**SCHOOL OF PUBLIC HEALTH**

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# PREVALENCE AND FACTORS ASSOCIATED WITH BLOOD TRANSFUSION-TRANSMISSIBLE INFECTIONS AMONG BLOOD DONORS IN THE WESTERN REGION OF GHANA

**BY**

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# DECLARATION

I, Hall Darren Enchill, declare that this thesis is my original work, except for duly referenced ones and that no form of this has been presented elsewhere wholly for the award of any degree.

**SIGN……………………………… ………NOV.07. 2024……..**

**HALL DARREN ENCHILL DATE**

**(STUDENT)**

**SIGN……_________________________… ……NOV.07. 2024…….**

**DR. ADDO – LARTEY ALDOPHINA DATE**

**(SUPERVISOR)**

# DEDICATION

I dedicate this thesis to my beloved wife, Martha Opoku, children, family, and all who supported me in making this dream a reality.

Thank you and may the good Lord bless you.

**ACKNOWLEDGEMENT**

I am deeply grateful for the abundant grace of the Almighty God that has brought me this far.

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I extend a very big thank you to all, and may the good Lord bless you.

Me da mo ase!!!

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AGH | Axim Government Hospital |
| AIDS | Acquired Immune Deficiency Syndrome |
| BTTI | Blood Transfusion -Transmissible Infection |
| BTTBIs | Blood transfusion-transmissible bacterial infections |
| BTTVIs | Blood transfusion-transmissible viral infections |
| BTTPIs | Blood transfusion-transmissible parasitaemia infections |
| CHAG | Catholic Health Association of Ghana |
| CSF | Cerebrospinal fluid |
| ENRH | Effia Nkwanta Regional Hospital |
| ELISA | enzyme-linked immunosorbent assay |
| GPNBBS | Ghana Policy for National Blood Bank Services |
| HAGH | Half Assini Government Hospital |
| HAV | Hepatitis A virus |
| HBV | Hepatitis B virus |
| HBsAg | Hepatitis B surface antigen |
| HCV | Hepatitis C virus |
| HIV | Human Immunodeficiency Virus |

| | |
|---|---|
| HTLV | Human T cell lymphotropic virus |
| IRDT | immunochromatographic rapid diagnostic tests |
| MOH | Ministry of Health 32 |
| MSM | men having sex with men |
| NAT | Nucleic Acid Testing |
| NBS | National Blood Service |
| PCR | Polymerase Chain Reaction |
| Rh’D’ | Rhesus factor D |
| SMH | St. Martin de Porres Hospital |
| STD | Sexually Transmitted Disease |
| TTI | Transfusion-Transmissible Infection |
| VDRL | Venereal Disease Research Laboratory |
| WHO | World Health Organisation |

## ABSTRACT

**Background**: Blood transfusion–transmissible infections (BTTIs) such as HIV, HBV, HCV, and *Treponema pallidum* pose major public health challenges due to their prolonged viraemia and potential for latent carriage. This study evaluated the prevalence and associated factors of BTTIs among blood donors in selected hospitals in the Western Region of Ghana.

**Methodology**: This study was a cross-sectional study using records review conducted at four purposively selected hospitals in the Western Region of Ghana. The data from the blood donors' registers from 2020 to 2023 were extracted onto an extraction log created in Microsoft Excel 2021, cleaned, and analysed using STATA version 17.0 software. Descriptive statistics were performed, and the results were presented in tables and charts. A chi-square test, linear regression model, and logistic regression test model were used to determine the variations in trends among blood-transfusion-transmissible infections and the relationship between independent and dependent variables.

**Results:** A total of 16,049 donor records were reviewed; 92.1% were males, with a mean age of 29 ± 7.8 years. Blood group distribution was O (69.3%), A (15.0%), B (14.3%), and AB (1.4%). The overall prevalence of BTTIs was 13.15% ($p \leq 0.001$), with HBV (5.58%) being most prevalent, followed by *T. pallidum* (4.69%), HCV (2.02%), and HIV (0.87%). The most frequent co-infection was HBV + *T. pallidum* (0.34%). Donors aged 20–29 years had higher odds of infection (OR = 1.68; 95% CI: 1.37–2.03), with the likelihood increasing among those aged 50 years or older (OR = 2.13; 95% CI: 1.39–3.26). Blood group O RhD-positive donors had the highest infection risk compared to other groups ($p \leq 0.001$)

**Conclusion:** HBV remains the predominant BTTI among blood donors in the Western Region of Ghana, followed by *T. pallidum*, HCV, and HIV. Age, sex, and ABO-RhD blood group were significantly associated with BTTI prevalence.

**Recommendations**: The study recommends improving donor record-keeping and screening accuracy through the adoption of ELISA testing and structured referral systems for reactive donors. It also calls on the Western Regional Health Directorate to intensify public health education and strengthen laboratory and surveillance systems to enhance blood safety and infection control.

# CHAPTER ONE

# INTRODUCTION

## 1.0 Background

The practice of blood transfusion as a therapeutic intervention has evolved significantly over time and has been responsible for saving millions of lives around the globe (Arora et al., 2010; Negash et al., 2019). According to the World Health Organisation (WHO, 2023) millions of units of blood are collected and transfused globally each year, underscoring the vital role of blood transfusion in healthcare delivery. Approximately 40% of these donations are collected in high-income countries, which represent only about 16% of the world's population, reflecting a significant inequity in global blood resource distribution. Blood donation rates per 1,000 population further illustrate this disparity, averaging 31.5% in high-income countries compared to only 5.0% in low-income settings.

While blood transfusions remain vital for saving lives, they inherently carry the risk of transmitting infections such as HIV-1 and 2, HBV, HCV, syphilis, and malaria. These infections can result in chronic disease, organ failure, and increased mortality among recipients. The residual risk of BTTIs is particularly elevated in low- and middle-income countries due to infrastructural limitations and inconsistencies in donor screening and quality control (Adu-Poku et al., 2020; Zaheer & Waheed, 2014). Globally, approximately 22.2% of the 81 million pints of blood donated each year, representing about 17.98 million units, are estimated to be at risk of contamination with BTTIs. This unsafe transfusion practice contributes to an estimated 5 million new hepatitis C virus (HCV) infections, 16 million hepatitis B virus (HBV) infections, and over 120,000 new human immunodeficiency virus (HIV) infections annually among blood recipients (Adu-Poku et al., 2020; Zaheer & Waheed, 2014). These statistics underscore both the global importance of blood transfusion and the urgent need to strengthen blood safety systems and quality assurance mechanisms within blood transfusion services, particularly in low- and middle-income countries.

Although the World Health Organisation (WHO) strongly recommends comprehensive screening of all blood donors for major transfusion-transmissible infections, ensuring consistent access to safe blood remains a major public health challenge in many developing countries, including Ghana (Negash et al., 2019; Sabir et al., 2023; Wondimu et al., 2013; WHO, 2023). Over the years, technological advances such as nucleic acid testing (NAT), enzyme-linked immunosorbent assay (ELISA), and immunochromatographic rapid diagnostic tests (IRDTs) have significantly improved blood safety by reducing the diagnostic “window period.” However, no technology can eliminate this period, leaving a residual risk of transfusion-related infection (Abdul-Wahab et al., 2022; Chaurasia et al., 2014; Hans & Marwaha, 2014). Despite screening efforts, studies have shown that recipients are still exposed to at least a 1.0% risk of transfusion-transmissible infections, largely due to inconsistent supply and quality of screening tools in resource-limited settings (Alumato et al., 2016; Field & Allain, 2007; Negash et al., 2019; Wondimu et al., 2013).

BTTIs are broadly classified into three categories: bacterial, viral, and parasitic infections. Blood transfusion–transmissible bacterial infections (BTTBIs) include *Treponema pallidum*—the causative agent of syphilis—and bacterial contaminants introduced through poor aseptic practices during collection or from donors with undiagnosed bacteraemia (Alumato et al., 2016; Shrestha, 2009). Blood transfusion–transmissible viral infections (BTTVIs) comprise pathogens such as human T-cell lymphotropic viruses (HTLV-I and II), HBV, HCV, hepatitis A virus (HAV), hepatitis E virus (HEV), and HIV-1 and 2, which pose significant global health concerns due to their potential to cause chronic infections and long-term morbidity (Alumato et al., 2016; Velati et al., 2018). Blood transfusion–transmissible parasitic infections (BTTPIs) include *malaria*, caused by *Plasmodium* species, and *babesiosis*, caused by *Babesia microti*, among others (Alumato, 2016; Shrestha, 2009).

In Ghana, blood donor screening is limited in scope. Routine testing is primarily restricted to HBV, HCV, HIV-1/2, and *T. pallidum*, which together account for approximately 66.7% of all BTTIs detected among blood donors. The exclusion of other potentially transmissible pathogens from standard screening protocols raises concerns about residual infection risk and underscores the need to enhance diagnostic capacity and surveillance within the national transfusion system. Strengthening these areas is critical to ensuring a sustainable supply of safe blood and reducing the burden of preventable transfusion-related infections (Abdul-Wahab et al., 2022). By evaluating data on the prevalence of Blood transfusion-transmissible infections (BTTIs) among blood donors, we can accurately estimate the risk of BTTIs (Adu-Poku et al., 2020). This assessment will help develop long-term strategies to improve public health and prevent the spread of diseases in the local population. In Ghana, like any other developing country, the people who engage in blood transfusion as part of life-saving procedures are mainly voluntary and replacement (family or relative) donors, who may be at risk of developing BTTIs. However, these challenges surrounding blood transfusion safety require critical attention. Although a few single-site and multi-site studies have been conducted in Ghana, they do not provide adequate representation of the regional or district-level distribution of blood transfusion–transmissible infections (BTTIs) among blood donors across the country (Walana et al., 2023).

## 1.1 Problem Statement

Blood transfusion–transmissible infections (BTTIs) remain a persistent global public health concern, threatening the safety of transfusion practices and the lives of recipients. Despite significant progress in donor screening, the transfusion of screened blood continues to result in serious health complications and fatalities (Aliyo et al., 2022a; Hong et al., 2016). A survey conducted by the World Health Organisation (WHO 2023), indicates that millions of blood donations are collected annually worldwide to save lives; however, a considerable proportion of these donations, particularly in low- and middle-income countries, remain at risk of transmitting infections due to gaps in testing and quality assurance systems.

Although standard protocols exist for screening blood donors for common pathogens such as *Treponema pallidum* (syphilis), hepatitis B virus (HBV), hepatitis C virus (HCV), *Plasmodium* species (malaria parasites), and human immunodeficiency virus (HIV 1 & 2), some of these infectious agents may escape detection—especially during the immunological "window period." This limitation contributes significantly to the residual risk of transmission even when screening results appear negative (Hong et al., 2016). The global burden of transfusion-transmissible infections is substantial, with unsafe transfusions estimated to cause approximately 5 million new HCV infections, 16 million HBV new infections, and 160,000 HIV infections annually (Adu-Poku et al., 2020; Bartonjo et al., 2019; Zaheer & Waheed, 2014). The transmission of BTTIs is influenced by multiple risk factors, including unprotected sexual activities with multiple partners, sharing of unsterilized drug injection equipment, tattooing, travel to high-endemic regions, and previous exposure to unsafe surgical procedures or transfusions (Jafri et al., 2006; Duda et al., 2005). These factors, combined with inadequate blood safety monitoring systems, increase the likelihood of new infections both among donors and within the general population. The persistence of such transmission dynamics not only elevates the risk to transfusion recipients but also undermines national efforts toward achieving a safe blood supply and universal health coverage.

If left unmitigated, the consequences of BTTIs are severe and far-reaching. Infected recipients may develop chronic infections such as hepatitis, liver cirrhosis, or HIV/AIDS, leading to increased morbidity and mortality. Furthermore, prolonged hospitalisations, treatment costs, and loss of productivity impose additional economic burdens on individuals, health institutions, and the national healthcare system. The cumulative impact of these infections emphasises the urgent need for continuous surveillance, enhanced diagnostic screening (such as nucleic acid testing), and evidence-based interventions to improve blood safety (Aliyo et al., 2022; Hong et al., 2016).

In Ghana, the challenge is further compounded by limited research and surveillance data on BTTIs among blood donors. Existing studies have been largely single-site and fragmented, failing to capture the districts and regional disparities and overall prevalence of these infections. Consequently, there is insufficient empirical evidence to guide national policy decisions and strengthen transfusion safety frameworks. Therefore, evaluating the prevalence and associated risk factors of BTTIs among blood donors across multiple sites in the Western Region of Ghana is critical. Such evidence will provide valuable insight for improving blood donor screening protocols, minimising transfusion-related infections, and safeguarding public health.

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### 1.2 Conceptual Framework

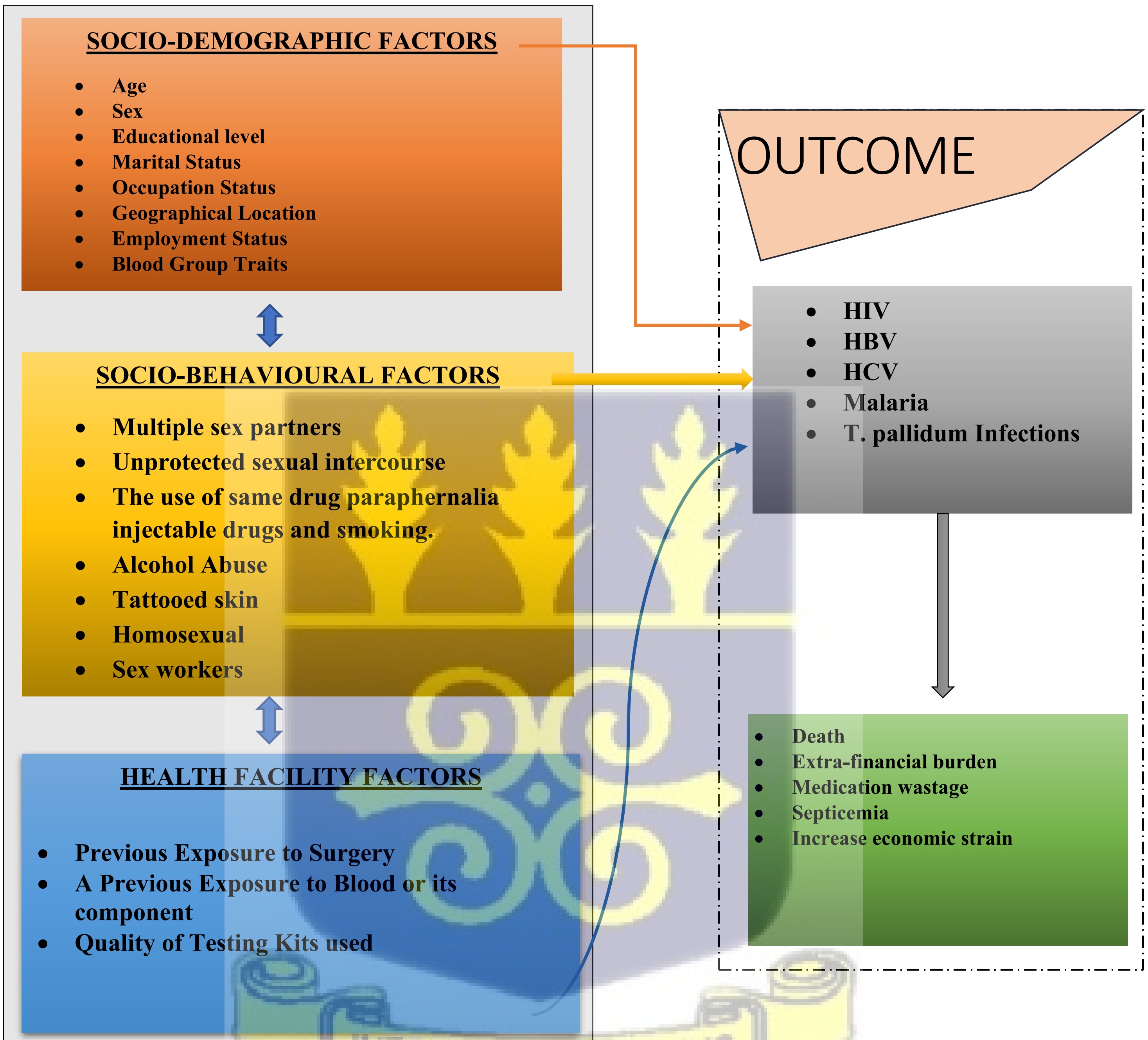



**Figure 1.1: showing a conceptual framework of factors and outcomes of BTTIs.**

### 1.3 Conceptual Framework Narrative

Figure 1.1 is a conceptual framework showing factors associated with a blood transfusion–transmissible infection among blood donors and its consequences. These factors are socio-behavioural, sociodemographic, and health facility factors. A study conducted by Adu-Poku et al., (2020) and Alumato et al., (2016) identified some socio-demographic factors like age, sex careers, employment, blood group traits (Anderson et al., 2021a), educational level (Jafri et al., 2006), and geographical location (Chaurasia et al., 2014). Some health facility factors found include earlier surgery or blood transfusions (Jafri et al., 2006; Duda et al., 2005). The inferior quality of screening tools used and their consistent supply in the country provide an aspect of the many reasons why BTTIs among the population are rising globally. These lead to false negative and false positive results (Alumato et al., 2016; Field & Allain, 2007; Negash et al., 2019). Some studies also found some behavioural factors like; drug paraphernalia, injectable drugs, tattoos (Jafri et al., 2006), unprotected sex, same-gender attraction, and multiple sex partners (Duda et al., 2005). These lead to some consequences like; septicemia, death, extra-financial burden, medication wastage, septicemia, and increased economic strain (Aliyo et al., 2022; Hong et al., 2016).

## 1.4 Justification

There is limited data available on the occurrence of BTTIs among blood donors in the Western Region of Ghana. This study is to provide appreciable data on the prevalence and pattern of BTTIs among blood donors in the local population to enhance public health in the region. This may also provide policymakers with enough data to understand the trend of BTTIs among blood donors in the Region. This will allow policymakers to direct interventions and resources to sustain a safe blood supply. The results of this study may also help strengthen and standardise the national blood policy on how laboratories screen blood donors for BTTIs and allow blood donors to know the possible types of BTTIs and provide them with knowledge about them.

## 1.5 Research Questions

i. What is the prevalence of blood transfusion transmissible infections (HIV, HBV, HCV, and T. pallidum) among blood donors?

ii. What is the prevalence of co-infection of BTTIs among blood donors?

iii. Is there any relationship between socio-demographic characteristics and transfusion-transmissible infections among blood donors?

iv. Is there any relationship between blood group traits and transfusion-transmissible infections among blood donors?

## 1.6 General Objective

To evaluate the prevalence and factors associated with blood transfusion-transmissible infections among blood donors in a multi-site health facility in the Western Region of Ghana.

### 1.7 Specific Objectives

1. To assess the prevalence of HIV, HBV, HCV, and T. pallidum among blood donors.
2. To determine the prevalence of co-infection of HIV, HBV, HCV, and T. pallidum among blood donors.
3. To determine the relationship between socio-demographic characteristics and transfusion-transmissible infections among blood donors.
4. To determine the relationship between blood group traits and transfusion-transmissible infections among blood donors.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Blood Donation

Blood transfusion unquestionably plays a crucial interventional role in the lifesaving of patients within health centres and hospitals, serving as an indispensable component of modern medical care. It provides essential supportive therapy in a wide range of clinical situations, particularly during emergency surgical operations, obstetric haemorrhages, and severe trauma cases such as fatal road traffic accidents that result in massive blood loss. Additionally, it remains a vital therapeutic option for patients suffering from profound anaemia arising from various conditions, including sickle cell disease, severe malnutrition, parasitic infections such as malaria, and complications associated with HIV and other chronic illnesses. By restoring blood volume, improving oxygen-carrying capacity, and stabilising patients in critical conditions, blood transfusion significantly enhances survival outcomes. Over the decades, this life-saving intervention has contributed to saving millions of lives globally and continues to be a cornerstone of emergency and routine medical care in both developed and resource-limited settings (Arora, 2010; Bloch et al., 2012; Negash et al., 2019; Walana et al., 2023).

## 2.2 Types of Blood Donors

To ensure the consistent availability of adequate and safe blood for lifesaving interventions, healthcare facilities primarily depend on the collection of blood from various sources. These sources include voluntary non-remunerated donors, who are considered the most reliable and safest group; family replacement donors, who contribute on behalf of their relatives or loved ones in need; autologous donors, who provide their own blood before surgical procedures for potential self-use; and, in certain contexts, commercial or paid donors, although this practice is generally discouraged due to associated safety and ethical concerns. Maintaining a steady and sufficient blood supply is a crucial aspect of healthcare delivery, facilitating timely transfusions in emergencies and routine medical care, which ultimately helps reduce preventable deaths linked to blood shortages (Alumato et al., 2016; Bloch et al., 2012).

### 2.2.1 Voluntary Donation

According to Bates et al. (2007), in 1975, the World Health Assembly (WHA) firmly endorsed the exclusive use of blood obtained from voluntary, non-remunerated donors for transfusions. This recommendation was based on substantial evidence indicating that voluntary donor blood is significantly safer than blood sourced from family replacements or commercial donors. The motivations for voluntary donations are typically altruistic rather than financial, leading to lower rates of transfusion-transmissible infections and enhancing overall blood safety. Given the increasing global demand for blood and its components, driven by surgical procedures, trauma care, obstetric emergencies, and the management of chronic anaemia, maintaining a consistent and reliable blood supply is essential. Achieving this objective relies heavily on establishing a well-organised and sustainable system of voluntary blood donations, supported by public education initiatives, effective donor retention strategies, and robust national blood service programs (WHO, 2023). Voluntary blood donation is precisely done through a centralised systemic approach to recruit nonremunerated voluntary blood donors. According to Bloch et al. (2012), organising a blood donation exercise that involves recruiting and maintaining donors for subsequent periods requires a lot of logistics and complex strategic methods. This is necessary to meet the demand for blood in a Healthcare setting. It is important to note that this type of donation can be up to eight times more expensive than a replacement donation from family members or friends (Bates et al., 2007). In Ghana, voluntary donations account for about 37% of blood donors, which is really on the bad side (NBS, 2020). There could be other factors influencing the low patronage of voluntary donors which might be due to an inactive legislative framework for blood services resulting in weak execution and compliance to standards of practice in educating the public concerning blood-saving life, the collection, screening, testing, storage, distribution, and usage of blood and blood components in the appropriate manner (NBS, 2020).

### 2.2.2 Family or Friends Replacement Donation

In Africa, around 78–80% of blood used for transfusions in healthcare settings comes from family replacement donors and friends of patients, a trend that is also seen in Ghana (Bates et al., 2007). In Ghana, blood supply also depends worryingly on replacement donations, which is almost about 63% of blood donors reported by the National Blood Service as of 2018 (NBS, 2020). A study conducted at Komfo Anokye Teaching Hospital compared the safety of blood donations from family and friends with that of voluntary, non-remunerated donors. The findings indicated that blood donations from family or friends tend to be less safe and less reliable compared to voluntary donations. This is largely due to the tendency of family or friends to withhold information regarding potential exposures to blood transfusion-transmissible infections (BTTIs) in their efforts to donate blood and save a loved one's life. Consequently, such donations were found to carry a risk of BTTIs that is 6.7 times greater than that associated with voluntary donors.



### 2.2.3 Paid or Commercial Donation

According to Ampofo et al. (2002), studies have shown that a notable proportion of young adults, particularly those aged 20 to 29 years, may engage in blood donation for financial or material incentives in some low and middle-income countries where voluntary blood donation systems are not fully developed. In contrast, in high-income countries such as the United States of America, regulated plasma donation programs allow donors to receive monetary compensation, while whole blood donation remains strictly voluntary. In some regions, incentives for donors may also include non-monetary benefits such as paid time off work or free health screening (Romer, 2021). Blood obtained from paid or commercial donors poses significant safety and ethical concerns. Evidence indicates that such donors are more likely to conceal critical information regarding their medical history, high-risk behaviours, or previous exposure to diseases due to the financial motivation associated with donation. This concealment undermines the integrity of the donor screening process and increases the likelihood of collecting blood that may be contaminated with transfusion-transmissible infections (TTIs). Consequently, blood from commercial donors is generally considered less reliable and less safe compared to that obtained from voluntary, non-remunerated donors (Ampofo et al., 2002). The primary motivation for commercial donors is financial gain, which may predispose them to intentionally conceal or omit important health-related or behavioural information during the screening process to increase their chances of being accepted as eligible donors (Centre, 2021; Chaurasia et al., 2014).

## 2.3 Blood Donation Process in Ghana

The Ghana Policy for National Blood Bank Service (GPNBBS) was established in February 2006. This policy was formulated in response to the escalating demand for safe and sufficient blood supplies nationwide, as well as the imperative to standardise blood transfusion practices. It functions as a foundational document guiding national initiatives aimed at establishing a sustainable, safe, and voluntary blood donation system that aligns with international standards and adheres to World Health Organisation (WHO) recommendations. The Ghana Policy for the

National Blood Service (GPNBS) establishes a comprehensive strategic framework that delineates the organisational structure, mandate, and governance of the National Blood Service in Ghana (M.O.H, 2006). This includes blood donor recruitment, selection and retention, blood collection, laboratory testing, blood component preparation, blood storage, blood distribution, blood quality assurance, blood clinical transfusion practice, code of ethics, financing of the National Blood Service, and the roles of all organisations involved in these processes, whether they are private or governmental entities. This policy aims to establish Hospital Blood Banks and equip Laboratory Technicians or Scientists who are certified to be responsible for patient blood grouping and cross-matching of screened blood at the Blood Centres for transfusion. They also perform other tasks, such as immunopharmacological services for the hospital when required, to ensure a sustainable national blood service (NBS, 2014, 2020).

Following the established policy and procedure, potential blood donors are required to register and complete a donor questionnaire. They undergo several physical and medical examinations, including a check of their haemoglobin levels, which must be at least 12.5g/dl for females and 13.0g/dl for males to be eligible to donate. Additionally, their vitals are checked. Donors then receive pre-donation counselling, during which they are informed about the blood donation process, post-donation care, and the potential outcomes of their donation. Blood samples are collected either before or during the donation to screen for HIV-1 and HIV-2, HBV, HCV, and syphilis (Chaurasia et al., 2014; NBS, 2020).

Furthermore, the policy emphasises the importance of offering motivational incentives to voluntary donors. In cases where a donor is disqualified during the screening process or has successfully donated, they are guided back to the counselling team for educational purposes before leaving the Health Centre premises (M.O.H, 2006; NBS, 2020). In many healthcare facilities, limited resources hinder the establishment of specialised clinics for the management of sexually transmitted infections (STIs), making it difficult to conduct confirmatory testing for blood transfusion-transmissible infections (BTTIs) other than HIV. As a result, blood donors who test positive during initial screening are often informed solely on the basis of preliminary results from the blood bank. In some cases, laboratory personnel lack the necessary training or resources to provide appropriate post-test counselling and referral services for these disqualified donors. This gap in policy implementation presents a significant public health concern, as it leaves infected individuals untreated and potentially unaware of their health status, thereby increasing the risk of continued transmission of BTTIs, particularly among sexually active young adults in the community (Chaurasia et al., 2014).

### 2.4 Blood Transfusion Transmissible Infection

Acquisition of Blood Transfusion Transmissible Infections (BTTIs) during transfusion of blood is a world health challenge that threatens blood transfusion safety. This raises a red flag in the healthcare setting due to its association with mortality and morbidity, which outshine the benefits of blood transfusion. Blood transfusion transmissible infections (BTTIs), when left untreated after acquisition through a blood transfusion at a health facility, can be a quiet killer (Al-Hatheq et al., 2019; Bonja et al., 2017; Melese & Tesfaye, 2016; Sabir et al., 2023).

According to a literature review Bloch et al., (2012), the prevalence of BTTIs can differ significantly depending on the population and geographic location. However, the limitations in data are common challenges in estimating the prevalence of these infections. In Africa, BTTIs can be classified into various groups based on the pathogens involved, with some of these agents being notable due to their geographic curiosity or the lessons they offer. These blood-transfusion transmissible infections can be grouped into viral, parasitemia, and bacterial infections.

Blood transfusion-transmissible viral infections (BTTVIs) including a diverse range of viruses such as human T cell lymphotropic virus (HTLV) I and II, hepatitis C virus (HCV), hepatitis B virus (HBV), Hepatitis A virus (HAV), Hepatitis E Virus, Hepatitis G virus, Chikungunya, Zika virus, Cytomegalovirus (CMV), West Nile Virus (WNV), Epstein Barr Virus (EBV), Human Herpesvirus 6, TT virus (TTV), SEN virus (SEN-V), HIV1 and 2, and Human Parvovirus B-19 (HPV-B19) and other emerging pathogens like Zika and West Nile virus, pose ongoing challenges to blood safety and highlight the need for continuous surveillance and improved screening strategies (Alumato et al., 2016; Velati et al., 2018).

Blood transfusion-transmissible parasitemia infections (BTTPIs), including Toxoplasmosis caused by *Toxoplasma gondii*, malaria infection caused by Plasmodium parasite species, babesiosis caused by *Babesia microti*, and Chagas disease caused by *Trypanosoma cruzi*, remain important public health challenges that underscore the need for improved donor screening and pathogen surveillance in blood transfusion services (Alumato, 2016; Shrestha, 2009).

Blood transfusion-transmissible bacterial infections (BTTBIs) represent a significant category of risks associated with transfusions. Commonly identified pathogens include Treponema pallidum, the causative agent of syphilis, Salmonella typhi, which causes typhoid fever, and various Gram-negative bacteria such as Yersinia enterocolitica, Citrobacter freundii, Escherichia coli, Pseudomonas aeruginosa, and Klebsiella pneumoniae. These organisms are frequently linked to the contamination of red cell concentrates and whole blood. Additionally, Gram-positive bacteria, including coagulase-negative Staphylococcus, Staphylococcus aureus, and Bacillus species, have also been recognised as occasional contaminants, capable of causing septic transfusion reactions and adverse clinical consequences (Bloch et al., 2012; Katz, 2009; Tsegaye et al., 2022).

### 2.4.1 Human Immunodeficiency Virus (HIV)

HIV is a deadly virus that damages the immune system by binding to the CD4 cell membrane receptors and replicating in the host cell through cell division, which leads to immune deficiency and severe infections (allowing the host to be exposed to infections that would not have caused illness). HIV is linked to three presentations, viz, asymptomatic infections, acute infection with symptoms, and acquired immune infections (AIDS). AIDS, which is accompanied by opportunistic infections, resulting in high mortality (Melese Abate & Tesfaye Wolde, 2016; Shrestha, 2009). Globally, Africa faces a substantial HIV burden. Sexual contact, unsafe blood transfusions, and needle reuse spread the virus. Vertical transmission occurs from mother to child during pregnancy and breastfeeding (Alumato et al., 2016; Bloch et al., 2012). HIV is mostly identified using various testing kits to display HIV-specific antibodies. Enzyme-linked immunosorbent Assays/Enzyme Immunoassays (ELISA) are the gold standard test mostly used in blood banks in testing for HIV, and to detect the genome in the infected cells using polymerase chain reaction techniques (PCR) (Melese Abate & Tesfaye Wolde, 2016). Globally, HIV is still a major public health concern, exerting a significant impact on social and economic development. In 2019, approximately 1.7 million new HIV infections were recorded globally, reflecting a 23% decline compared to 2010. Nevertheless, despite intensified global interventions, progress towards further reduction has stagnated, with about 500,000 new infections still being reported in 2020 (WHO, 2021).

### 2.4.2 Hepatitis B Virus (HBV)

Hepatitis B is classified under Hepadnaviridae. HBV has been a major public health threat that has hit the world severely compared to HIV. Two billion people are infected with HBV worldwide despite the availability of prophylaxis (Osei-Boakye et al., 2023; Walana et al., 2023). Out of 350 million people who get infected with HBV, 25% die from Chronic hepatitis, cirrhosis, and hepatocellular carcinoma (Melese Abate & Tesfaye Wolde, 2016). The mode of viral transmission is via blood-to-blood contact from an infected person to an uninfected person. It can be transmitted through birth, unprotected sexual intercourse, and multiple blood infusions (Dwyre et al., 2011). Homosexuals and individuals who indulge in the use of the same drug paraphernalia, injectable drugs, are at a higher risk of developing the infection. There is much debate surrounding the mode of transmission (Adjei et al., 2008, 2019; Alumato et al., 2016). Immunoassays targeting HBV surface antigen rapid test kits are mostly used to detect the presence of the infection (Bloch et al., 2012).

### 2.4.3 Hepatitis C Virus (HCV)

Hepatitis C virus is a blood-borne infection also associated with Chronic hepatitis, cirrhosis, and hepatocellular carcinoma. 854 per 100,000 population get infected with HCV globally. In the WHO African region, 2054 per 100,000 population get infected with HCV. The Hepatitis C virus, like HBV, also causes Chronic hepatitis, cirrhosis, and hepatocellular carcinoma. In 2019, 290,000 deaths recorded worldwide by the WHO were associated with Hepatitis C infection. Current data profs that 3 million people get infected annually from HBV and HCV, developing into both acute and chronic infections, of which 1.1 million deaths are associated with the infections (Alharazi et al., 2022; Dwyre et al., 2011; WHO, 2021).

### 2.4.4 *Treponema pallidum* (syphilis)

Syphilis is a systemic disease that is caused by a bacterium named *Treponema pallidum*. Which gets spread in the population through unprotected sex, unsafe blood transfusions, and vertical transmission (Melese Abate & Tesfaye Wolde, 2016; PHE, 2017). A study carried out by Alharazi et al. (2022) showed that men are 1.8 times more at risk of syphilis infection compared to women.

Treponema pallidum is a Gram-negative bacterium characterised by its coiled shape, which is propelled by three flagella that wrap around its surface. It divides approximately every 30 hours through a process called binary fission. This microorganism is sensitive to water and drying, and it thrives in environments with low oxygen levels, typically between 1% and 4%. Presently, rabbit tests serve as the main method to grow the organism for diagnostic research. T. pallidum's characteristics and limited viability outside the host make it challenging for laboratory study and necessitate specific growth conditions (Shrestha, 2009). The Venereal Disease Research Laboratory (VDRL) test detects syphilis. It was introduced in the year 1946 (Shrestha, 2009). Globally, syphilis was the first infection found for its risk of blood transfusion. Effective quality assurance for laboratory refrigerators in Ghana is often compromised by high ambient temperatures, making the environment unsuitable for the proper storage of refrigerated red cells. Nonetheless, *Treponema pallidum* is unlikely to thrive under such conditions (Alumato et al., 2016; Shrestha, 2009).

Our focus will be on HIV, HBV, HCV, and T. pallidum since they are the major BTTIs focused on in Ghana and many developing countries when it comes to blood donation screening and transfusion purposes.

## 2.5 Prevalence of HIV, HBV, HCV, and T. Pallidum Infections among Blood Donors

Blood transfusion is an essential life-saving medical procedure; however, it carries the risk of transmitting infections from donors to recipients. Understanding the prevalence and factors associated with blood transfusion-transmissible infections (BTTIs) is therefore crucial to ensuring blood safety and reducing the risk of disease transmission among recipients. The burden of Blood Transfusion-Transmissible Infections (BTTIs) is higher in developing nations, with a prevalence rate ranging from 1.03% to 3.70% compared to 0.003% to 0.05% in developed countries (Aabdien et al., 2020). In the African region, North West Ethiopia has reported a BTTI prevalence of 5.4%, while a multicenter study in Ghana revealed a significantly higher rate of 21.0% (Legese et al., 2022; Walana et al., 2023).

In Africa, HIV-associated BTTIs prevalence ranges from 5% to 10%, with viral hepatitis causing post-transfusion infections at 12.5% with comparatively low T. pallidum infections associated with BTTI (Alharazi et al., 2022; Bartonjo et al., 2019). HIV affects about 38.4 million people globally, with Africa hosting two-thirds of the cases. This highlights the urgent need for awareness and resources to confront this global health challenge (WHO, 2022). The overall prevalence of HIV in Ghana is 1.6%, with variations across the country ranging from less than 1% to 2.8%. The Western Region has recorded a prevalence of 2.7% among the general population, making it the second highest in the country (Ali et al., 2019).

Both acute and chronic HBV infections in Africa affect over 50 million people, with up to 20% chronic carriers in Sub-Saharan Africa (Osei-Boakye et al., 2023). Ghana's HBV prevalence is 3.3% to 7.5% with an overall prevalence of 6.6%, causing complications like cirrhosis and liver carcinoma (Walana et al., 2023). It is recorded that approximately 150 million people worldwide are infected with HCV, with 8% of these cases occurring in the African region, resulting in 500,000 deaths annually (Gill et al., 2016; Osei-Boakye et al., 2023). A recent study has indicated that the prevalence of Hepatitis C Virus (HCV) among blood donors in Koforidua is 8.0%. This finding underscores the importance of rigorous screening and monitoring of blood donations to ensure the safety of the blood supply and protect recipients from potential infections (Alumato et al., 2016; Bloch et al., 2012). Globally, syphilis is recorded to have affected about 6 million people, with African women showing prevalence rates from 0.36% to 3.6%, and blood donors ranging from

0.71% to 20% (He et al., 2023; Walana et al., 2023). According to Walana et al., (2023) the prevalence of HBV, HCV, HIV, and Syphilis (*T. pallidum*) in some selected parts of Ghana as of 2022, was 6.6% (385/5868), 4.9% (286/5830), 2.9% (168/5867), and 6.8% (393/5739), respectively. These findings were noted among voluntary donors who stepped forward to donate blood to save lives, highlighting the persistent risk of transfusion-transmissible infections within the blood donation system. The observed prevalence levels emphasise the importance of ongoing screening, effective donor education, and strong surveillance mechanisms to ensure blood safety and reduce the transmission of transfusion-related diseases in Ghana.

Numerous efforts have been undertaken to raise awareness about the prevalence of HIV, HBV, HCV, and T. pallidum, as these four major diseases continue to pose significant challenges for developed, developing, and underdeveloped countries seeking lasting solutions to protect blood recipients from their harmful effects. In Ghana, a notable gap exists, particularly regarding the limited understanding of the trends in the prevalence of BTTIs over time. This limited data hampers the ability to ascertain whether these infections are increasing or decreasing across the sixteen regions and various districts. Gaining insights into how BTTIs are evolving will be crucial for evaluating the impact of interventions, new policy formulations, advanced screening technologies, and public health campaigns (Alumato et al., 2016, He et al., 2023, Walana et al., 2023).

## 2.6 Prevalence of BTTIs Co-Infections among Blood Donors

The transmission pathways for HBV, HCV, HIV, and T. Pallidum remain unchanged. The primary routes of transmission include sexual intercourse, mother-to-child transmission, and blood transfusion. These are means of direct contact transmissions of BTTIs (Gong et al., 2020). In HIV-infected patients, an estimated 4 million have chronic HBV co-infection and 5 million have HCV co-infection. HBV, HCV, and HIV have varying prevalence based on geographical distribution and modes of transmission (Alter, 2006; Shrestha et al., 2012). Research shows a link between syphilis and a higher risk of getting HIV. Many people acquire both infections simultaneously, suggesting a connection. The increase in cases of T. Pallidum and HIV supports this association. Syphilis, transmitted through sexual contact, often indicates risky sexual behaviours, increasing the chances of contracting HIV and other infections (Alter, 2006; Karp et al., 2009; Peterman et al., 2015). In the USA, a systematic review of studies carried out has revealed that about 15.7% (interquartile range [IQR]: 13.6-21.8%) of the Public with T. Pallidum were co-infected with HIV (Blocker et al., 2000). Another study carried out by Gong et al. (2020), in China, revealed that the various stages of *Treponema pallidum* infection were significantly associated with HIV infection, with a prevalence of 8.2% (AOR 1.88; 95% CI 1.12–3.15). Syphilis, particularly caused by T. Pallidum, increases the risk of HIV transmission. This occurs because genital ulcers, like those from T. Pallidum, create a break in the mucosal barrier, allowing HIV easier access into the body. Additionally, these ulcers may attract more CD4+ cells to the site, which are the primary targets for HIV, thereby increasing susceptibility (Karp et al., 2009). In individuals infected with HIV, *Treponema pallidum* has been shown to enhance HIV transmission by increasing viral shedding. Research indicates that many people who contracted both HIV and syphilis did so simultaneously, suggesting a connection between T. Pallidum infection and heightened susceptibility to HIV (Reynolds et al., 2006). According to Gong et al. (2020) and Heiligenberg et al. (2012), T. pallidum-associated co-infection with HIV occurs more in men than women, especially among the youth, since they indulge in much unprotected sexual intercourse with multiple partners and MSM.

In a study conducted in China, the prevalence of HCV and HBV co-infection among individuals identified with *Treponema pallidum* was 1.02% (14/1,374) and 5.75% (82/1,427), respectively. The study concluded that HCV and HBV infections may not be significantly associated with *T. pallidum* infection (Heiligenberg et al., 2012). In a similar study conducted by Shrestha et al., (2012) in Nepal, South Asia, among 139 blood donors with HCV infection, a total co-infection rate of 5.75% (95% CI: 2.52–11.03) was reported. The prevalence rates of HCV co-infection with HIV, HBV, and *Treponema pallidum* were 3.59%, 0.71%, and 1.43%, respectively. The authors concluded that co-infections involving HIV, HBV, and *T. pallidum* among HCV-infected donors were relatively common, and recommended further research with a larger sample size to better understand the patterns of co-infection. A similar prospective cross-sectional study conducted by Alumato et al., (2016) in the Eastern Region of Ghana reported an overall prevalence of co-infections among blood donors of 2.35% (10/426). Among these, the prevalence of HIV–HCV co-infection was 0.47%, HIV–*T. pallidum* co-infection was 0.24%, HBV–*T. pallidum* co-infection was 1.17%, and HCV–*T. pallidum* co-infection was 0.47%. The study further revealed that HBV and *T. pallidum* represented the most common co-infection combination among blood donors in the region.

In another study conducted in the Kintampo North Municipality Hospital by Walana et al. (2014), reported co-infection cases among 643 infected blood donors in the following descending order: HBV co-infection with HCV (45.5%), HIV co-infection with HCV (27.3%), HIV co-infection with HBV (18.2%), HIV co-infection with both HBV and HCV (4.5%), and HIV-1 co-infection with HIV-2 (4.5%). No *T. pallidum* co-infections were recorded, indicating that the study primarily focused on viral infections among blood donors in that geographical area. This finding appears to contrast with results reported by other researchers, which may be attributed to differences in geographical location, sample size, and study design. The relatively small sample size and the cross-sectional nature of the study may have introduced incidence–prevalence bias, thereby limiting the generalizability of the findings to all blood donors in Ghana. Moreover, the unequal distribution of geographical and socio-demographic characteristics across the country further supports the need for region-specific investigations. Therefore, it is essential to assess the prevalence and patterns of blood transfusion-transmissible infection (BTTI) co-infections among blood donors in the Western Region of Ghana, considering a four-year trend, to generate evidence that can inform and strengthen policy decisions for blood banking and transfusion services in the region.

## 2.7 Factors Associated with Blood Transfusion-Transmissible Infections (BTTIs) among Blood Donors

Several factors have been associated with blood transfusion-transmissible infections (BTTIs) among blood donors. These factors include demographic characteristics such as age, sex, and occupation, as well as socio-behavioural determinants that influence the risk of infection.

### 2.7.1 Demographic Factors

Several studies have demonstrated that, in the demographic distribution of blood donors by sex and age, male donors consistently outnumber females, with most donations obtained from individuals aged 18 to 58 years. The highest proportion of donors is typically seen within the 20–29-year age group, whereas the lowest representation occurs among those above 40 years**.** Moreover, blood transfusion transmissible infections (BTTIs) have been found to occur more frequently among donors younger than 40 years, suggesting a possible association between younger age and increased risk of infection (Aliyo et al., 2022; Alumato et al., 2016; Heiligenberg et al., 2012; Legese et al., 2022; Melku et al., 2021). Older adults are likely to have experienced greater cumulative exposure to risk factors over time, including surgical interventions, previous blood transfusions, and high-risk behaviours associated with infections such as HIV and viral hepatitis. These cumulative exposures increase their susceptibility to blood transfusion transmissible infections (BTTIs) (Busch & Satten, 1997; Candotti & Allain, 2009). Ageing can also affect the efficiency of the immune system, which increases susceptibility to infections, including BTTIs. Older adults may not clear infections as effectively as their younger counterparts (Pawelec, 2018).

In many studies in Ghana, it has also been reported that males are much more exposed to blood-transfusion-transmissible infection compared to females (Altayar et al., 2022; Walana et al., 2023). Comparable studies conducted in Ethiopia, Saudi Arabia, and Ghana have reported similar demographic trends among blood donors. These findings have been partly attributed to cultural and societal norms in certain settings that discourage or restrict women from donating blood, thereby contributing to the observed male predominance among donors (Adu-Poku et al., 2020; Aklil & Temesgan, 2022; Altayar et al., 2022). This bias originates from the belief that women, who naturally lose blood during their menstrual cycle, may experience health issues or weakness if they donate a pint of blood (Altayar et al., 2022). In contrast, studies from European countries such as the United Kingdom, the United States, France, the Netherlands, and Denmark reveal no significant differences in the demographic distribution of male and female blood donors. Furthermore, the prevalence of blood transfusion transmissible infections (BTTIs) among donors in these countries is notably low, reflecting the impact of stringent donor selection criteria, effective screening protocols, and robust public health systems (Melku et al., 2021; Smith et al., 2021). This is an important observation, as cultural practices and socioeconomic factors can significantly influence both the prevention and susceptibility to blood-transfusion-transmissible infections (BTTIs) and sexually transmitted infections (STIs). Understanding these contextual differences is essential for developing targeted public health interventions, enhancing awareness, and reducing the transmission of such infections. From an occupational perspective, healthcare workers are at a comparatively higher risk of contracting BTTIs due to iatrogenic exposures, such as accidental needle-stick injuries and direct contact with infectious body fluids, including blood, urine, stool, sputum, and cerebrospinal fluid (CSF) (Shrestha, 2009; Walana et al., 2014)

### 2.7.2 Socio-Behavioural Factors

Some studies reported some socio-behavioural factors or lifestyles that lead to one getting exposed and contracting blood-transfusion-transmissible infections. According to Heiligenberg et al., (2012), high-risk sexual behaviours such as men having sex with men (MSM), engaging in sexual relations with multiple partners, the use of shared sex toys, rimming with multiple partners, sharing enemas before intercourse, unprotected sexual activity, and the use of drugs before sexual contact significantly elevate the risk of contracting infections such as HIV, hepatitis B virus (HBV), hepatitis C virus (HCV), and *Treponema pallidum* (the causative agent of syphilis). Similarly, other studies have demonstrated that the sharing of unsterilized injecting equipment among drug users, the use of non-sterile instruments for tattooing, as well as engagement in commercial sex work and multiple sexual partnerships, are major routes through which individuals may acquire various BTTIs (Duda et al., 2005; Jafri et al., 2006; Walana et al., 2023).

## 2.8 ABO-Rh Blood Group

The red blood cell (RBC), also known as the erythrocyte, is the most predominant cell type in the human circulatory system. It is a biconcave, disc-shaped cell composed primarily of proteins and iron-containing haemoglobin, which facilitates the transport of oxygen from the lungs to body tissues and the removal of carbon dioxide from tissues to the lungs for exhalation. To date, 34 blood group systems have been identified; however, the ABO blood group system remains the most widely recognised and clinically significant due to its fundamental role in blood transfusion compatibility (Cooling, 2015). The ABO blood group system is controlled by a gene found on chromosome 9. The ABO blood group system consists of three alleles: A, B, and O. O is recessive, while both A and B are dominant. (Alharazi et al., 2022; Cooling, 2015; Gylmiyarova et al., 2018). The surface of the RBC is made up of different proteins called antigens and polysaccharides, which form the blood group antigens of the four main blood groups: A, B, AB, and O, among humans. The ABO blood group antigens are polymorphic traits that are inherited from individuals' human parents (Alharazi et al., 2022; Altayar et al., 2022; Legese et al., 2022). In the formation of these ABO group antigens, the enzyme ABO glycosyltransferase uses the H antigen as a substrate. The addition of H-glycosyltransferase produces the H antigen, which is attached to the surface of the red blood cells. Group B population express 1–3 galactose (Gal) on their H antigen on their red blood surface, those in Group A express 1-3 N-acetylgalactosamine (GalNAc) on their H antigen on their red blood surface, and Group O populations, express just the H-antigen precursor as an antigen on their red blood surface and have dormant ABO genes (Altayar et al., 2022; Cooling, 2015). According to Cooling (2015), red cells and ABH antigens are also expressed in various tissues and secretions such as the heart, intestinal mucosa, kidney, endothelium, and other organs.

Blood can be classified into four main groups using both forward and reverse blood groupings. In forward blood grouping, monoclonal or polyclonal antibodies are used to detect the expression of A and B antigens on red cells through agglutination. In reverse grouping, commercial group A and B red cells are incubated with an individual's plasma or serum to detect naturally occurring anti-A and anti-B antibodies (Cooling, 2015). To determine a person's blood type, it is important to check for antibodies against any missing A or B antigens. For instance, individuals with blood group AB express both antigens A and B but do not have anti-B and anti-A antibodies. On the other hand, individuals with blood group O, who do not express both antigens, have both anti-A and anti-B antibodies. To confirm a person's blood type, the results of both forward and reverse grouping tests must match (Alharazi et al., 2022; Cooling, 2015). ABO antibodies are an essential part of the body's innate immune system. They fight against harmful bacteria and viruses that carry ABO-active antigens. Interestingly, blood groups can act as decoy receptors, which are used by bacteria, viruses, and parasites as receptors and ligands. For example, the Duffy blood group antigen serves as a receptor for various malarial parasites, including Plasmodium vivax (Langhi & Bordin, 2006).

## 2.9 Prevalence of ABO – Rh Blood Groups

A study conducted by Patel and Shah (2022) investigated the distribution pattern and possible association between transfusion-transmitted infections (TTIs) and ABO/Rh blood groups over five years (2016–2020) at the Prathama Blood Centre in Ahmedabad, India. Out of a total of 143,687 healthy voluntary blood donors included in the study, the findings revealed that the B Rh(D) positive blood group was the most prevalent (33.62%), while the AB Rh(D) negative blood group was the least common (0.52%). Another study conducted by Alabdulmonem et al. (2020) in Saudi Arabia explored data from blood donors at Buraidah Central Hospital Blood Bank between 2017 and 2018. The study included 4,590 healthy voluntary blood donors, among which the highest percentage of blood donors belonged to O Rh 'D' positive blood group 42%, followed by A Rh 'D' positive 23.4%, B Rh 'D' positive 20.9%, O Rh'D' negative 5.45%, AB Rh'D' positive 3.4%, A Rh'D' negative 2.8%, B Rh'D' negative 2.1%, and AB Rh'D' negative 0.5%. It's interesting to note that Legese et al. (2022) conducted a study in Ethiopia that looked at the data of over 27,000 blood donors at the Bahir Dar Blood Bank from 2019 to 2021. The study found that blood group O was the most common at 41.4%, followed by A at 29.6%, B at 23.6%, and AB at 5.4%. Most donors, 91.7%, were Rh (D) positive. In Ghana, a study conducted by Walana et al., (2023), indicated that blood groups that were predominately donated in the multi-centres including Nkwanta South Municipal Hospital in the Oti region, Weija-Gbawe Municipal Hospital in the Greater Accra region, SDA Hospital in the Northern region, and Wa Municipal Hospital in the Upper West region, where the study took place were O Rh'D' Positive, followed by B Rh'D' positive, A Rh'D' positive, and O Rh 'D' negative. An indication of the O blood groups and Rh'D' Positive being predominant in the country.

## 2.10 Association between ABO-Rh Blood Group and Blood Transfusion-Transmissible Infections among Blood Donors

Several studies have examined the association between ABO and Rh(D) blood groups and the risk of blood transfusion transmissible infections (BTTIs). Evidence from some of these studies suggests that individuals with ABO or Rh(D) blood groups lacking certain antigens may have a higher susceptibility to BTTIs compared to those possessing these antigens, indicating a possible immunological influence of blood group antigens on infection vulnerability (Legese et al., 2022; Yang et al., 2022). Research conducted by Tyagi et al. (2013) demonstrated that individuals with the B Rh(D) negative blood group were more likely to be infected with *Treponema pallidum* (syphilis). In contrast, those with the A Rh(D) negative blood group showed a higher susceptibility to HIV and hepatitis B virus (HBV) infections. Another study conducted by Anderson et al. (2021) involving 107,796 blood donors found no significant association between ABO blood groups and susceptibility to COVID-19 infection. Based on these findings, the authors concluded that ABO blood group phenotypes are unlikely to serve as useful predictors of disease outcomes at the population level, particularly among populations with similar environmental exposures and genetic ancestries.

The study by Patel and Shah (2022), revealed some interesting findings related to transfusion transmissible infections and blood groups. According to the study, both RhD-positive and RhD-negative blood groups showed a significant link with HBV and T. pallidum transfusion-transmissible infections. Moreover, the study found that seropositivity for BTTIs was higher in Rh D-positive donors, particularly those with blood group B Rh'D' positive, 0.19%. However, the study did not find any significant association between BTTIs and other blood groups, except for one B Rh'D' negative blood group that showed seropositivity for HCV. A study by Legese et al., (2022), also found that there was no significant association between the ABO blood group and all BTTI markers. Rh blood type also showed no association with all BTTIs.

A recent study by Altayar et al. (2022) conducted at the King Faisal Specialist Hospital and Research Centre (KFSH & RC) in Saudi Arabia analysed a seven-year dataset comprising approximately 959,431 blood donors from 2013 to 2019. The study reported a weak correlation between ABO and Rh blood groups and the occurrence of blood transfusion transmissible infections (BTTIs). Furthermore, it was observed that the O blood group was the most prevalent, whereas the AB blood group was the least common. This distribution pattern has been found to be consistent across populations in both Asia and Africa.

However, further studies are needed to establish a stronger connection between blood group ABO-Rh and blood transfusion-transmitted infections (BTTIs) in African countries and regions, especially in Ghana and other regions across Africa. These studies have demonstrated gaps, inconsistencies, and contradictions, which require further investigation.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Study Design

This retrospective cross-sectional study utilised four years of secondary data (2020–2023) obtained from hospital records to determine the prevalence and identify factors associated with blood transfusion-transmissible infections among blood donors. The study was conducted at four hospitals in the Western Region of Ghana: Effia Nkwanta Regional Hospital, Axim Government Hospital, St. Martin de Porres Hospital, and Half Assini Government Hospital. The data on sex, age, blood group, HIV, HBV, HCV, and T. pallidum were extracted from the four health facilities' donor screening registers into a well-designed extraction log generated in Microsoft Excel version 2021(**Appendix I**). The data were quality-controlled using a double-entry mechanism. The data were cleaned and transferred to STATA, and subjected to statistical analysis, and inferences were made.

## 3.2 Study Site

The Western Region is found in the southwestern part of Ghana. The region can be located on the map of Ghana between the coordinates: Latitude: 5° 29' and 59.99" N, Longitude: 2° 29' and 59.99" W. The region landmarks from the Central region in the east to the Ivory Coast in the west, include the capital and large twin city of Sekondi-Takoradi on the coast, coastal Axim, and a hilly inland area including Elubo (in Jomoro district).

According to the Ghana Statistical Services, the current population of the Western region is approximately 2,060,585 people, with a slightly higher proportion of males (50.7%) than females (49.3%) (GPHC, 2021). Out of the 2,060,585 people, about 1,062,865 (51.60%) live in the urban area sectors. At the same time, about 997,720 (48.4%) live in rural communities (GPHC, 2021).

The region comprises 14 districts and has a total of 614 health facilities. These facilities include 36 hospitals, 55 health centres, 109 clinics, 398 functional CHPS compounds, and 16 maternity homes. These are owned by the government, Christian Health Associations, private organisations, and quasi-governmental health organisations.

The four main selected facilities are found at the following locations in the Western Region of Ghana: Effia Nkwanta Regional Hospital (ENRH) in the Sekondi Takoradi Metropolitan Assembly, which happens to be the capital town of the Western region. St. Martin de Porres Hospital (SMPH) is a general Hospital belonging to the Christian Health Association of Ghana (CHAG) in the Ellembelle District. Half Assini Government Hospital (HAGH) is a district hospital belonging to the Ministry of Health in the Jomoro Municipal District, located in the capital Half Assini. Axim Government Hospital (AGH) in the Nzema East Municipal District, belonging to the Ministry of Health, is situated in Axim, the capital of the district.

The four health facilities were purposively selected based on their relatively higher annual performance in blood donation and transfusion services compared to the remaining facilities, reflecting their critical contribution to supporting and sustaining human life. The Half Assini Government Hospital is located approximately 52 kilometres from St. Martin de Porres Hospital, which takes about 1 hour and 45 minutes to drive. St. Martin de Porres Hospital is about 40 kilometres away from Axim Government Hospital, with a drive time of around 1 hour. Additionally, St. Martin de Porres Hospital is roughly 96 kilometres from Effia Nkwanta Regional Hospital, which takes about 3 hours to reach. Although all four health facilities are located within the same geographical region and share similar demographic and epidemiological characteristics, data were analysed by study site to identify possible micro-level variations in blood donor characteristics and infection prevalence.

## 3.3 Study Variables

### 3.3.1 Outcome / Dependent Variables

The outcome of interest was blood transfusion transmissible infections (BTTIs), including HBV, HIV, HCV, and T. pallidum.

### 3.3.2 Exposure / Independent Variables

**Sociodemographic Factors**

a. Sex: Biological classification as a female or a male.

b. Age: The age of the participant.

c. Blood group traits: Blood group of participants.

**Table 3.1 Study variables, operational definition, type and scale of measurement**

| No | Variable | Operational Definition | Type of Variable | Scale of Measurement |
|---|---|---|---|---|
| **DEPENDENT VARIABLES** | | | | |
| 1 | HIV (1&2) | Screening for HIV infection types (positive/negative) | Binary | Nominal |
| 2 | HBV | Screening for Hepatitis B virus infection (positive/Negative) | Binary | Nominal |
| 3 | HCV | Screening for Hepatitis C virus infection (positive/Negative) | Binary | Nominal |
| 4 | T. pallidum | Screening for Syphilis infection (Positive/Negative) | Binary | Nominal |
| 5 | | | | |
| **INDEPENDENT VARIABLES** | | | | |
| 1 | Age | How old is the donor at the time of data extraction (in years) | Continues | Ratio |
| 2 | Sex | What is the biological classification of a patient (male or female) | Binary | Nominal |
| 3 | Blood Group | Screening for blood group and rhesus trait (A Rh'D' +ve, A Rh'D'-ve, B Rh'D'+ve, B Rh'D'-ve, O Rh'D'+ve, O Rh'D'-ve, AB Rh'D'+ve, AB Rh'D'-ve) | Polychotomous | Nominal |

## 3.4 Study Population

The target population for the study were healthy individuals in the Western Region, between the ages of 18 and 55 years who are blood donors in the Western region of Ghana.

## 3.5 Sampling Frame

The sampling frame consisted of healthy individuals within the age range of 18 to 55 years who visited any of the four Hospitals: Effia Nkwanta Regional Hospital, Axim Government Hospital, St. Martin de Porres Hospital, and Half Assini Government Hospital to donate blood, either as a voluntary, family replacement or during a blood donation campaign.

### 3.6 Sample Population

The sample population were healthy individuals between the ages of 18 and 55 years, qualified by all screenings, and willingly agreed to donate blood at any of the four hospitals, with their details captured in the blood donor screening registers.

### 3.7 Sample Size Determination

This study was a retrospective census over four years. Hence, all data captured in the blood donors´ screening registers of the four Hospitals within the four years (January 2020 to December 2023) were utilised.

### 3.8 Donor Selection, Screening, Blood Storage, and Record Keeping

All four selected health facilities adhered to uniform standard operating procedures (SOPs) for screening blood donors to donate and process blood for storage. At these sites, a potential blood donor underwent a physical examination and a selection interview. Additionally, haemoglobin estimation was performed either by using a copper sulphate method or an automated haematology analyser. A pre-donation screening for BTTIs, including HBV, HCV, HIV 1&2, and T. pallidum, was performed, as well as blood grouping. A successful donor who goes through all the various selection processes and screening is prepared for the bleeding process. A 450 ml pint of blood was collected into a CPDA-1 blood bag and labelled during the bleeding. The label on the blood bag includes the donor's unique identification number, the date of blood collection, the expiry date of the collected blood, the ABO and Rh of the blood, and the results of the BTTIs tested. Afterwards, the blood was refrigerated at a temperature between 2◦C to 8 ◦C in the blood bank fridge. Screening results, including the donor's demographics, name, age, and sex, are captured in the donor screening register.

## 3.9 Sampling Procedure

A total enumerative sampling was employed to capture data from the first to last page of donors from the donor screening registers at the blood banks of the four selected hospitals.

## 3.10 Sample Collection Technique

The donor screening registers archived from 2020 to 2023, were retrieved by the research assistants to make data available to capture for the study. Data on age, sex, blood group, rhesus factor D, HBV, HCV, T. pallidum, and HIV, about donors who met the inclusion criteria, were captured from the donor screening registers from the blood bank at Effia Nkwanta Regional Hospital (ENRH), Axim Government Hospital (AGH), ST. Martin de Porres Hospital (SMPH) and Half Assini Government Hospital (HAGH), into the extraction log developed in Microsoft Excel version 2021. The data capturing lasted for about six weeks.

## 3.11 Inclusion Criteria

All blood donors who were between the ages of 18 and 55 years who agreed to donate blood, screened for blood group, HIV, HBV, HCV, and T. pallidum, and with complete data in the blood bank screening registers were included in the study.

## 3.12 Exclusion Criteria

All donors between the ages of 18 and 55 years who agreed to donate blood and screened for blood group, HIV, HBV, HCV, and T. pallidum, with incomplete data in the blood bank donor screening registers, were excluded from the study.

## 3.13 Data Quality Control

### 3.13.1 Training of Research Assistant

One research assistant was assigned to each of the four selected facilities and was trained on data extraction procedures from the donor screening registers into a Microsoft Excel extraction log. The training covered the objectives of the study and equipped the research assistants with the skills to accurately apply the inclusion and exclusion criteria when reviewing the registers, thereby ensuring the systematic and consistent identification of relevant data for extraction.

### 3.13.2 Pretesting Extraction Log

The data extraction tool was pretested among the very first 30 donors in the screening register at all four sites in the Western Region. This helped to identify any discrepancies in the extraction log Excel tool. After pretesting, all identified gaps were corrected before using the tool for data collection.

### 3.13.3 Data Handling

Data were cross-checked for errors and corrected. The Excel data file and other electronic data were password-protected, and access was limited to the principal investigator and supervisor only. To minimise the effect of missing or inconsistent entries, all donor records were first screened for completeness before inclusion. Incomplete records, missing critical variables such as sex, age, or test outcomes, were excluded from the analysis. Potential inconsistencies and duplicate entries were cross-checked against original blood donor registers and corrected in consultation with the blood bank managers of the participating facilities. While these measures reduced data errors, residual inconsistencies may still exist, and this limitation has been duly acknowledged in the discussion of study limitations.

### 3.13.4 Data Processing

Data were extracted from the donor screening registers at the four study sites using a customised extraction log in Microsoft Excel 2021. The data were then cleaned and cross-checked for completeness, duplicates, range, and consistency. For example, participants aged under 18 and over 55 years were considered invalid. Cleaned data variables were converted to their given labels (**APPENDIX II)** and imported to Stata version 17 for statistical analysis and drawing of inferences.

### 3.14 Statistical Analysis

Data were statistically analysed using Stata version 17.0 statistical software. Independent variables such as age were summarised as a mean and standard deviation (SD), and categorical data such as blood groups and rhesus as percentages (%). Prevalence of HIV, HBV, HCV, T. pallidum and co-infections was expressed as percentages for the entire study group. Data were presented using frequency tables and charts. The linear regression model was utilised to evaluate the trends in the periodic prevalence of blood transfusion-transmissible infections across the various study sites and the prevalence of HIV, HBV, HCV, and T. pallidum in the Western region of Ghana. The chi-square test was used to test the variations in trends among blood transfusion transmissible infections and the prevalence of co-infection of HIV, HBV, HCV, and T. pallidum among blood donors. A logistics regression was used to assess the relationship between the independent variables and dependent variables, i.e., the association between socio-demographic characteristics and blood transfusion-transmissible infections among blood donors, and the relationship between blood group traits and transfusion-transmissible infections among blood donors. Before performing logistic regression, essential model assumptions were examined to ensure the validity of statistical inferences. The normality of continuous variables was assessed using the Shapiro–

Wilk test and visual inspection of histograms. The linearity of continuous predictors with the logit of the dependent variable was checked using the Box–Tidwell procedure. Multicollinearity among independent variables was evaluated using the Variance Inflation Factor (VIF), with all values found to be below the acceptable threshold of 10, indicating no significant multicollinearity. These diagnostic checks confirmed that the data met the requirements for valid logistic regression analysis.

### 3.16 Ethical Consideration

Ethical clearance was sought from the Ghana Health Service Ethics Review Committee (ERC) before the commencement of the study.

### 3.17 Study Approval

Study approval was obtained from the Western Regional Health Directorate, and the four Health facilities: Effia Nkwanta Regional Hospital, Axim Government Hospital, St. Martin de Porres Hospital, and Half Assini Government Hospital's Medical Superintendents, Administrators, and blood bank managers in the Western region before the commencement of the study.

### 3.12 Risk And Benefits of The Study

There was less risk, and the donors' screened registers were used for statistical analysis. The names and contact details of donors were not extracted to ensure anonymity. The results of the study may be used to improve healthcare at Blood Transfusion Centres.

# CHAPTER FOUR

# RESULTS

## 4.0 Introduction

Preliminary diagnostic tests confirmed that the dataset met the key assumptions required for logistic regression analysis. No major deviations from normality, linearity, or independence of observations were detected. Multicollinearity was not a concern, as all Variance Inflation Factor (VIF) values were below 10. Similarly, assessments of standardised residuals and leverage values revealed no influential outliers. These findings confirmed the suitability of the data for reliable logistic regression modelling.

During the study period, from January 2020 to December 2023, data were extracted from the donor screening registers of four study sites in the Western Region of Ghana: Effia Nkwanta Regional Hospital**,** Axim Government Hospital**,** St. Martin de Porres Hospital, and Half Assini Government Hospital. A total of 16,845 donor records were initially retrieved. After data cleaning and validation in Microsoft Excel, complete datasets for 16,049 donors were kept and subsequently analysed using STATA version 17.0**.**

## 4.1 Descriptive Statistics of Socio-demographic Characteristics

In Table 4.1, out of the 16,049 blood donors, 14,776 (92.07%) were male donors and 1,273 (7.93%) were female donors. 22% (3,524/16/049) of the study group data were captured at Efia Nkwanta Regional Hospital, 16% (2,557/16049) of the study group were captured from Axim Government Hospital, 49% (7841/16049) of the study group were captured from St. Martin de Porres hospital, and 13% (2127) of the study group were captured at Half Assini Government Hospital. The minimum age of the blood donors recorded was 18 years, and the maximum was 55 years, with both the interquartile range and median age being 28 years. The mean age was 29.08 ± 7.80 years. Most blood donors were within the age range of 20-29 years (48.69%) and 30-39 years (30.49%).

The least donors were found to be between 50 and 55 years old ($\bar{X} \pm SD$; 29.08± 7.80) years. In terms of their blood group traits, most blood donors were blood group O (69.31%), followed by A (15.00%), B (14.27%) and the least blood group AB (1.42%). Details are shown in Table 4.1.

**Table 4.1 Sociodemographic Features of Blood Donors from 2020 to 2023 in the Western Region of Ghana.**

| ***Demographic Features*** | **Frequency** | **Percentage (%)** |
|---|---|---|
| ***Age (years)*** | | |
| *<20yrs* | 1,502 | 9.36 |
| *20-29yrs* | 7,814 | 48.69 |
| *30-39yrs* | 4,894 | 30.49 |
| *40-49yrs* | 1,642 | 10.23 |
| *>50yrs* | 1,97 | 1.23 |
| ***Total*** | **16,049** | **100.00** |
| Mean ± SD | 29.08 ± 7.80 | |
| ***Sex*** | | |
| *Male* | 14,776 | 92.07 |
| *Female* | 1,273 | 7.93 |
| ***Total*** | **16,049** | **100.00** |
| **Blood Trait** | | |
| **O** | 11,123 | 69.31 |
| ***A*** | 2,408 | 15.00 |
| ***B*** | 2,290 | 14.27 |

| | | |
|---|---|---|
| ***AB*** | 228 | 1.42 |
| ***Total*** | **16,049** | **100.00** |
| ***Rhesus 'D'*** | | |
| **Positive** | 15,026 | 93.63 |
| **Negative** | 1,2023 | 6.37 |
| **Total** | **16,049** | **100.00** |
| ***ABO Blood Group & Rhesus D' Traits*** | | |
| O+ | 10,368 | 64.60 |
| A+ | 2,278 | 14.19 |
| B+ | 2,168 | 13.51 |
| AB+ | 212 | 1.32 |
| O- | 755 | 4.7 |
| A- | 130 | 0.81 |
| B- | 122 | 0.76 |
| AB- | 16 | 0.10 |
| ***Total*** | **16,049** | **100.00** |
| ***Hospitals*** | | |
| Effia Nkwanta Regional Hospital | 3,524 | 22.00 |
| Axim Government Hospital | 2,557 | 16.00 |
| St. Martin de Porres Hospital | 7,841 | 49.00 |
| Half Assini Government Hospital | 2,127 | 13.00 |
| **Total** | **16049** | **100.00** |
| ***Year*** | | |
| *2020* | 3,121 | 19.45 |

| | | |
|---|---|---|
| *2021* | 3,113 | 19.40 |
| *2022* | 4,642 | 28.92 |
| *2023* | 5,173 | 32.23 |
| ***Total*** | **16,049** | **100.00** |

At Effia Nkwanta Regional Hospital, data from 3,524 blood donors were captured between 2020 and 2023, comprising 2,683 males and 841 females. The mean age of donors was 25.21 ± 8.12 years. At Axim Government Hospital, data were obtained from 2,577 blood donors within the same period, of whom 2,390 were males and 167 were females. The donors had a mean age of 29.84 ± 7.50 years. At St. Martin de Porres Hospital, a total of 7,841 donor records were captured between 2020 and 2023, representing the largest number of blood donors among the study sites. The mean age of donors at this facility was 30.44 ± 7.52 years. Finally, at Half Assini Government Hospital, data from 2,127 blood donors were extracted, consisting of 2,077 males and 51 females, with a mean age of 29.50 ± 6.43 years. A summary of these findings is presented in Table 4.2 below.

**Table 4.2 Distribution of sociodemographic features of blood donors at The Study Sites in the Western Region for The Period 2020 - 2023.**

| **Year** | **2020**<br>**n (%)** | **2021**<br>**n (%)** | **2022**<br>**n (%)** | **2023**<br>**n (%)** | **Total**<br>**N** |
|---|---|---|---|---|---|
| **Total Donors Screened** | 3,121 | 3,113 | 4,642 | 5,173 | 16049 |
| **Effia Nkwanta Regional Hospital** | | | | | |
| **Sex** | | | | | |
| Male | 559 (86.13) | 601(81.44) | 661(77.04) | 862(67.40) | 2683 |
| Female | 90(13.87) | 137(18.56) | 197(22.96) | 417(32.60) | 841 |

| | | | | | |
|---|---|---|---|---|---|
| **Total** | **649** | **738** | **840** | **1,274** | **3524** |
| **Age Group** | | | | | |
| <20yrs | 222(34.21) | 231(31.30) | 324(37.72) | 332(25.96) | 1109 |
| 20-29yrs | 251(38.67) | 316(42.82) | 334(38.72) | 677(52.93) | 1578 |
| 30-39yrs | 118(18.18) | 135(18.29) | 125(14.55) | 171(13.37) | 549 |
| 40-49yrs | 50(7.70) | 48(6.50) | 60(6.98) | 86(6.72) | 244 |
| >50yrs | 8(1.23) | 8(1.08) | 16(1.86) | 13(1.02) | 45 |
| **Mean± *SD*** | 25.86 ± 8.40 | 25.37 ± 8.13 | 24.84 ± 8.39 | 25.04 ± 7.77 | 25.21±8.12 |
| **Axim Government Hospital** | | | | | |
| **Sex** | | | | | |
| Male | 525(94.94) | 581(90.92) | 780(94.32) | 504(93.68) | 2390 |
| Female | 28(5.06) | 58(9.08) | 47(5.68) | 34(6.32) | 167 |
| **Total** | **553** | **639** | **827** | **538** | **2,557** |
| **Age Group** | | | | | |
| <20yrs | 22(3.98) | 19(2.97) | 24(2.90) | 24(4.46) | 89 |
| 20-29yrs | 309(55.88) | 336(52.58) | 403(48.73) | 262(48.70) | 1310 |
| 30-39yrs | 153(27.67) | 203(31.77) | 284(34.34) | 199(36.99) | 839 |
| 40-49yrs | 64(11.57) | 72(11.27) | 100(12.09) | 44(8.18) | 280 |
| >50yrs | 5(0.90) | 9(1.41) | 16(1.93) | 9(1.67) | 39 |
| **Mean± *SD*** | 29.16 ± 7.59 | 29.76 ± 7.36 | 30.40 ± 7.60 | 29.80 ± 7.38 | 29.84±7.50 |
| **St. Martin de Porres Hospital** | | | | | |
| **Sex** | | | | | |
| Male | 1,494(96.51) | 1,272(96.36) | 2,292(97.82) | 2,568(97.64) | 7626 |
| Female | 54(3.49) | 48(3.64) | 51(2.18) | 62(2.36) | 215 |
| **Total** | **1,548** | **1,320** | **2,343** | **2,630** | **7,841** |
| **Age Group** | | | | | |
| <20yrs | 50(3.23) | 44(3.33) | 62(2.65) | 79(3.00) | 235 |
| 20-29yrs | 755(48.77) | 612(46.36) | 1,140(48.66) | 1,255(47.72) | 3,762 |
| 30-39yrs | 559(36.11) | 492(37.27) | 840(35.85) | 908(34.52) | 2,799 |
| 40-49yrs | 164(10.59) | 151(11.44) | 276(11.78) | 354(13.46) | 945 |
| >50yrs | 21(1.29) | 21(1.59) | 25(1.07) | 34(1.29) | 100 |
| **Mean± *SD*** | 30.18 ± 7.27 | 30.50 ± 7.74 | 30.38 ± 7.33 | 30.66 ± 7.75 | 30.44±7.52 |

| | | | | | |
|---|---|---|---|---|---|
| **Half Assini Government Hospital** | | | | | |
| **Sex** | | | | | |
| Male | 364(98.38) | 403(96.64) | 601(97.88) | 708(97.66) | 2,077 |
| Female | 6(1.62) | 14(3.36) | 13(2.12) | 19(2.34) | 50 |
| **Total** | **370** | **417** | **614** | **727** | **2,127** |
| **Age Group** | | | | | |
| <20yrs | 10(2.70) | 21(5.04) | 20(3.26) | 18(2.48) | 69 |
| 20-29yrs | 228(61.62) | 262(62.83) | 312(50.81) | 364(50.00) | 1,166 |
| 30-39yrs | 107(28.92) | 104(25.94) | 214(34.85) | 282(38.84) | 707 |
| 40-49yrs | 22(5.95) | 28(6.71) | 65(10.59) | 58(7.99) | 172 |
| >50yrs | 3(0.81) | 2(0.48) | 3(0.49) | 5(0.69) | 13 |
| **Mean± *SD*** | 28.86 ± 6.31 | 28.40 ± 6.22 | 30.01 ± 6.92 | 30.02 ± 6.06 | 29.50±6.43 |

**4.2 Descriptive statistics of blood group ABO traits among blood donors at the study sites.**

Figure 4.1 shows the distribution of blood groups among blood donors for the period between 2020 to 2023 in the Western Region of Ghana. Blood group O appears to be the most predominant blood type, followed by A, B, and AB being the least among the blood group types. The study found that, at Efia Nkwanta, 50% (1,762/3,524) of the blood donors were blood group O, 22.79% (803/3,524) of the blood donors were blood group A, 22.96% (809/3,524) were blood group B, and 4.26% (150/3,524) were found to blood group AB. At Axim Government Hospital, the study found that 82.28% (2,104/2,557) of the donors were blood group O, 9.15% (234/2,557) of blood donors were blood type A, 8.9% (212/2,557) of blood donors were blood group B, and 0.27% were blood group AB over the study period. At St. Martin de Porres Hospital, the study found that 70.67% (5,541/7,841) of the blood donors were blood group O, 15.16% (1,189/7,841) of the donors were blood group A, 13.40% (1,051/7,841) of the donors were blood group B, and 0.77%

(60/7,841) of blood donors were blood group AB for the period 2020 to 2023. At Half Assini Government Hospital, the study found that 80.71% (1,716/2,126) of blood donors were blood group O, 8.6% (182/2,126) of blood donors were blood group A, 10.25% (218/2,126) of blood donors were blood group B, and 0.47% (10/2,126) of blood donors were blood group AB.

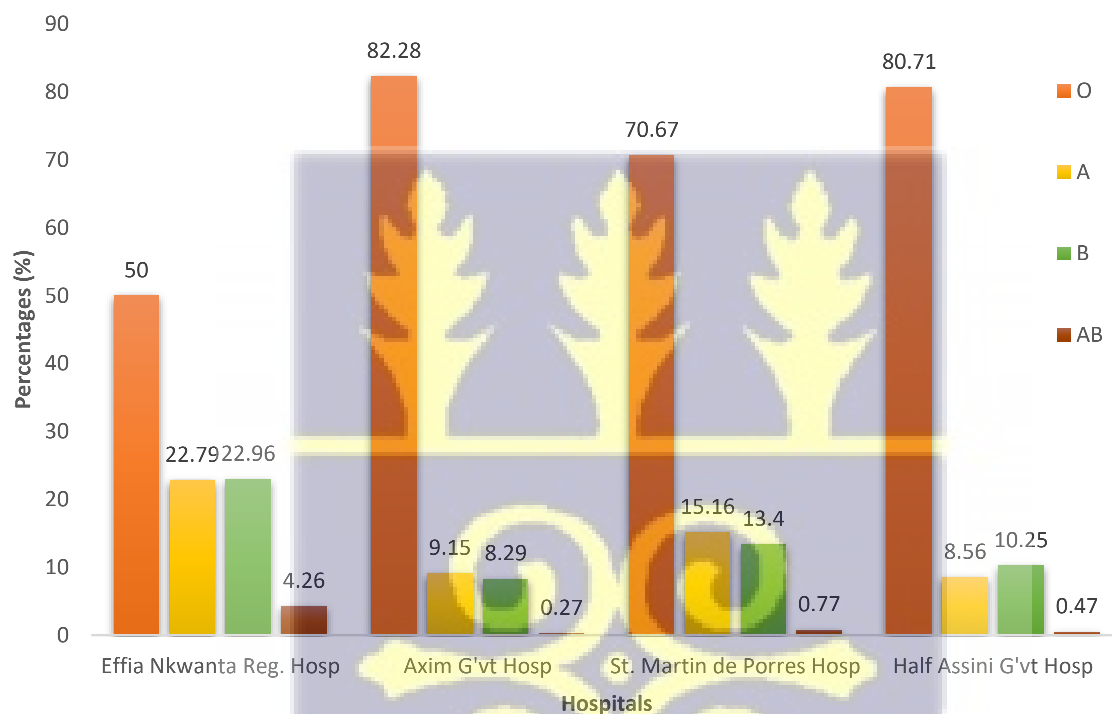



***Figure4.1: The distribution of blood group among blood donors across the four study sites in 2020-2023.***

**4.3 A Temporal Periodic Prevalence Trend of Blood Transfusion Transmissible Infections among Blood Donors from 2020 to 2023 by Study Sites.**

Table 4.3 shows a yearly prevalence and a temporal periodic trend of blood transfusion-transmissible infections by study sites. At Axim Government Hospital, the periodic percentage prevalence of BTTIs was found to be 46.34% at 95% C. I (38.65 54.03), 46.35% at 95% C. I (39.81 52.89), 46.36% at 95% C. I (39.81 52.90) and 46.36% at 95% C. I (338.67 54.05) in the years 2020, 2021,2022, and 2023, respectively. A p-value of ≤ 0.001 was found, indicating that the prevalence was statistically significant with no variation in trend. At Effia Nkwanta Regional Hospital, a low yearly percentage prevalence of BTTIs was found, 5.99% at 95% C. I (-1.70, 13.68) in 2020, 6.00% at 95% C. I (-0.55, 12.54) in 2021, 6.00% at 95% C. I (-0.54, 12.55) in 2022, and 6.01% at 95% C. I (-1.68, 13.70) in 2023. A p-value > 0.050 was found throughout the study period, an indication of no statistical significance in BTTIs prevalence. A similar low percentage in periodic prevalence of BTTIs was found at Half Assini Government Hospital, with 3.13% at 95% C. I (-4.56, 10.82) in 2020, 3.13% at 95% C. I (-3.41, 9.68) in 2021, 3.14% at 95% C. I -3.40, 9.68) in 2022, and 3.15% at 95% C. I (-4.54, 10.84) in 2023. This was not statistically significant, with varying p-values greater than 0.050 across the study period. At St. Martin de Porres Hospital, the annual prevalence of blood transfusion-transmissible infections (BTTIs) has remained consistently high over the years. From 2020 to 2023, the recorded prevalence rates were 44.51% (95% CI: 36.82–52.20), 44.52% (95% CI: 37.98–51.06), 44.53% (95% CI: 37.98–51.07), and 44.53% (95% CI: 36.84–52.22), respectively. The consistently low p-value (≤ 0.001) indicates that these yearly prevalence estimates were statistically significant, showing no variation in trend across the study period.

**Table 4.3: A Periodic Prevalence Percentage of Blood Transfusion – Transmissible Infections by Study Sites.**

| Study Sites | Year | BTTIs Prevalence (%) | 95% C. I | P-Value |
|---|---|---|---|---|
| Axim G'vt Hospital | 2020 | 46.34 | 38.65 54.03 | |
| | 2021 | 46.35 | 39.81 52.89 | |
| | 2022 | 46.36 | 39.81 52.90 | ≤ 0.001 |
| | 2023 | 46.36 | 38.67 54.05 | |
| Efia Nkwanta Reg. Hospital | 2020 | 5.99 | -1.70 13.68 | 0.114 |
| | 2021 | 6.00 | -0.546 12.54 | 0.069 |
| | 2022 | 6.00 | -0.540 12.55 | 0.068 |
| | 2023 | 6.01 | -1.68 13.70 | 0.113 |
| Half Assini G'vt Hospital | 2020 | 3.13 | -4.56 10.82 | 0.390 |
| | 2021 | 3.13 | -3.41 9.68 | 0.314 |
| | 2022 | 3.14 | -3.40 9.68 | 0.313 |
| | 2023 | 3.15 | -4.54 10.84 | 0.387 |
| St. Martin de Porres Hospital | 2020 | 44.51 | 36.82 52.20 | |
| | 2021 | 44.52 | 37.98 51.06 | |
| | 2022 | 44.53 | 37.98 51.07 | ≤ 0.001 |
| | 2023 | 44.53 | 36.84 52.22 | |

**4.4 Periodic Temporal Prevalence Trends of Blood Transfusion Transmissible Infections among Blood Donors 2020-2023 in The Western Region.**

Table 4.4 shows the periodic prevalence percentage trends of BTTIs (HBV, HCV, HIV, and VDRL) among blood donors from the four-year study period in the Western Region of Ghana. The study found a percentage prevalence of HBV from 7.0% at 95% CI (5.93, 8.07), to 6.38% at 95% C.I (5.38, 7.37), to 5.76% at 95% C.I (4.69, 6.83), to 5.14% at 95% (3.87, 6.41), in the years 2020, 2021, 2022, and 2023, respectively. The prevalence percentage trend of HBV shows a decreasing periodic trend and was statistically significant with a p-value ≤ 0.001. The study found a yearly decreasing percentage prevalence trend of HCV among blood donors in the Western region from 3.10% at 95% C.I (2.06, 4.15), 2.48% at 95% C.I (1.60, 3.36), 1.86% at 95% C.I (0.98, 2.75), and 1.24% at 95% C.I (0.20, 2.29). This was statistically significant and shows a decrease in HCV percentage prevalence trend throughout the study period with a p-value ≤ 0.024. The study found a decreased prevalence trend of T. pallidum from 2020 to 2023, from 5.95% at 95% C.I (4.90, 7.00), to 5.33% at 95% C.I (4.50, 6.16), to 4.71% at 95% C.I (3.94, 5.49), and to 4.09% at 95% C.I (3.19, 5.00) respectively.

The periodic trend and prevalence percentage of T. pallidum were statistically significant with a p-value ≤ 0.001. The study found a decreasing percentage prevalence trend of HIV from 1.77% at 95% C. I (0.72, 2.81) in 2020 to 1.15% at 95% C. I (0.27, 2.03) in 2021 was found to be statistically significant with a p-value <0.050. The percentage prevalence of HIV at 0.53% at 95% C.I (-0.35, 1.41) in 2022 and -0.09% at 95% C.I ( -1.13, 0.96) in 2023. This was found not to be statistically significant with a p-value > 0.050.

**Table 4.4: A Periodic Temporal Trend of BTTIs in The Western Region of Ghana.**

| Transfusion Transmissible Infections | YEAR | PREDICTED PREVALENCE (%) | 95% C. I | P-VALUE |
|---|---|---|---|---|
| HBV | 2020 | 7.0 | 5.93 8.07 | |
| | 2021 | 6.38 | 5.38 7.37 | |
| | 2022 | 5.76 | 4.69 6.83 | ≤ 0.001 |
| | 2023 | 5.14 | 3.87 6.41 | |
| HCV | 2020 | 3.10 | 2.06 4.15 | ≤ 0.001 |
| | 2021 | 2.48 | 1.60 3.36 | ≤ 0.001 |
| | 2022 | 1.86 | 0.98 2.75 | 0.001 |
| | 2023 | 1.24 | 0.20 2.29 | 0.024 |
| VDRL | 2020 | 5.95 | 4.90 7.00 | |
| | 2021 | 5.33 | 4.50 6.16 | |
| | 2022 | 4.71 | 3.94 5.49 | ≤ 0.001 |
| | 2023 | 4.09 | 3.19 5.00 | |
| HIV | 2020 | 1.77 | 0.72 2.81 | 0.003 |
| | 2021 | 1.15 | 0.27 2.03 | 0.015 |
| | 2022 | 0.53 | -0.35 1.41 | 0.213 |
| | 2023 | -0.09 | -1.13 0.96 | 0.855 |

**4.5 Prevalence of Blood Transfusion Transmissible Infections (HBV, HCV, T. pallidum, and HIV) in The Western Region.**

Among the 16,049 blood donors captured from the four study sites between 2020 and 2023, the study found that 13.15% (2,111/16,049) tested positive for HIV, HBV, HCV, T. pallidum, and coinfections. Out of the 13.15% of blood donors who tested positive for the BTTIs, 5.58% (895/16049) were positive for HBV, 1.89% (303/16049) for HCV, 0.74% (119/16049) for HIV, and 4.15% (667/16049) for T. pallidum and 0.74% (127/16049) were co-infections: figure 4.2.

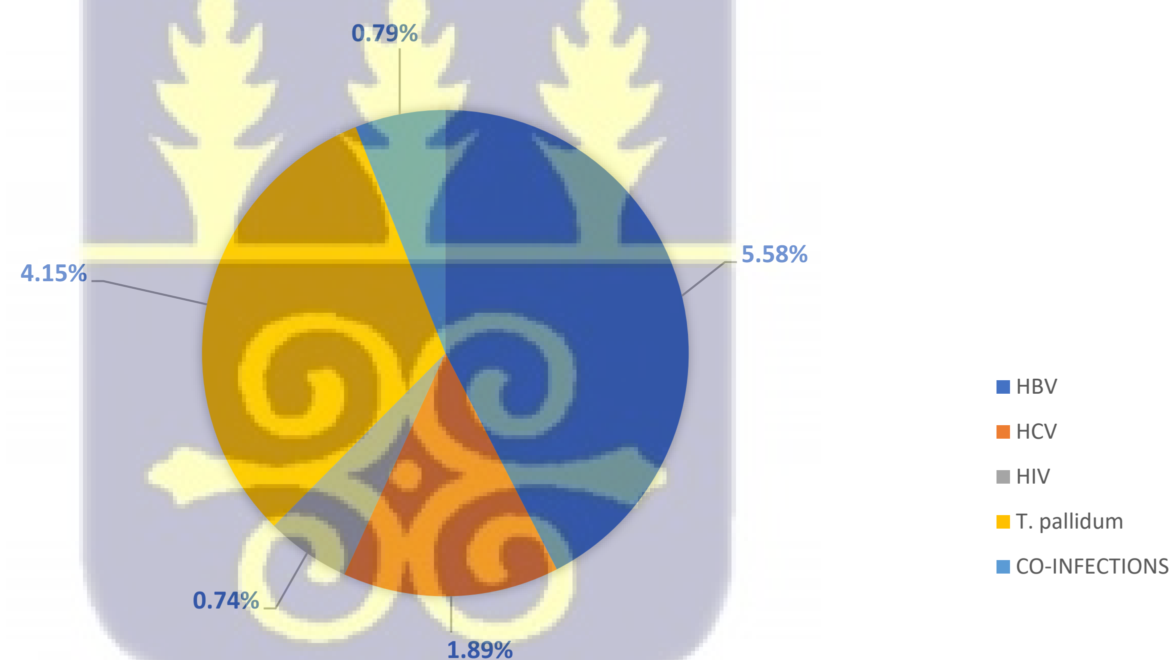



Figure 4.2: Prevalence of blood transfusion transmissible infection among the 2111 blood donors who tested positive for the period 2020 - 2023

**4.6 The Prevalence of Blood Transfusion Transmissible Infections by Study Sites in The Western Region.**

Figure 4.3 projects the prevalence of blood transfusion transmissible infections among blood donors who were screened at the four study sites in the Western region. The study found that HBV, HCV, T. pallidum and HIV were prevalent among the 16,049 blood donors for the study period 2020 to 2023. In the case of HBV, the study found a higher percentage of 3.05% (490/16,049) among blood donors at St. Martin de Porres Hospital and 1.86% (298/16,049) of blood donors at Axim Government Hospital, and a decrease in 0.50% (79/16,049) and 0.17% (27/16,049) of blood donors at Effia Nkwanta Regional Hospital and Half Assini respectively. The study found a decreasing order of 1.09% (175/16,049), 0.72% (116/16,049), 0.17% (27/16,049), and 0.03% (5/16,049) of HCV among blood donors at Axim Government Hospital, St. Martin de Porres Hospital, Effia Nkwanta Regional Hospital, and Half Assini, respectively. The study found an increase of 2.93% (470/16,049) and 1.66% (267/16,049) prevalence of T. Pallidum among blood donors at Axim Government Hospital and St. Martin de Porres Hospital, respectively. A decreased prevalence of 0.22% (36/16,049) was found among blood donors at Effia Nkwanta Regional Hospital, and a prevalence of 0.08% (12/16,049) was found at Half Assini Government Hospital. The prevalence of HIV among blood donors was found to be 0.38% (61/16,049), 0.29% (46/16049), 0.12% (19/16,049), and 0.08% (13/16,049) at St. Martin de Porres Hospital, Axim Government Hospital, Half Assini Government Hospital, and Effia Nkwanta Regional Hospital, respectively.

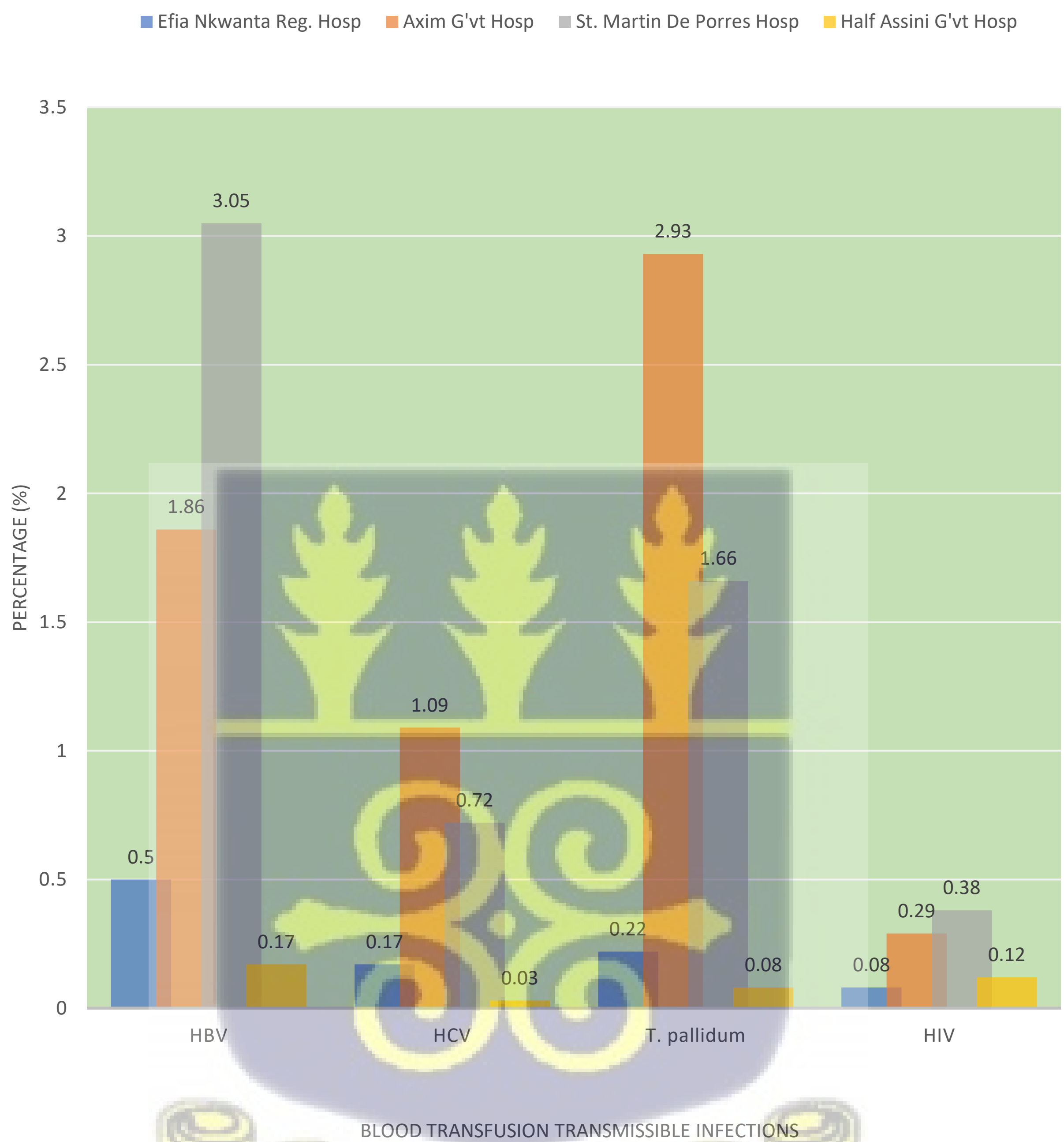



Figure 4.3: Prevalence of blood transfusion transmissible infections among blood donors in the Western Region.

**4.7 The Association between BTTIs and Age Groups of Blood Donors at The Selected Sites for the Period 2020-2023.**

Table 4.5 shows the association between blood transfusion transmissible infections and age groups of blood donors. Blood donors in older age groups from 20 - 29 years and above were more likely to develop BTTIs compared to blood donors in the age group ≤ 20 years. The study found an increased odds ratio of 1.68 at a 95% C.I (1.37 – 2.03) with a p-value ≤ 0.001 among blood donors between 20 - 29 years. This shows that blood donors within the age range 20 – 29 years old have 68% increased odds of testing positive for BTTIs compared to the blood donors who are 20 years old and younger, and this was statistically significant. The study also found an increased odds ratio of 1.93 at a 95% C. I (1.58 – 2.36) among blood donors between 30 - 39 years. This shows that blood donors within the age range 30 – 39 years old have 93% increased odds of testing positive for BTTIs compared to the reference blood donors who are 20 years old and younger, and this was statistically significant with a p-value ≤ 0.001. Blood donors within the 40–49-year age group showed a significantly higher likelihood of testing positive for blood transfusion transmissible infections (BTTIs), with an odds ratio (OR) of 2.08 (95% CI: 1.65–2.61; p ≤ 0.001). This shows that donors who were 40 to 49 years of age had 2.08 times higher odds of being infected with BTTIs compared to those in the reference age group.

The study found that donors who were 50 years and above had 2.13 times higher odds of being infected with BTTIs compared to donors who were 20 years and younger. This was found to be statistically significant (p-value = 0.001, 95% C.I.: 1.39 – 3.26).

**Table 4.5 The Association between Blood Transfusion Transmissible Infections and Age Groups of Blood Donors for the Period 2020-2023**

| Age Group (Years) | BTTIs (Positive) | BTTIs (Negative) | Total | P-Value | OR | 95%CI |
|---|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | | | |
| ≤ 20 | 121 (0.75) | 1,381 (99.25) | 1502 (100.00) | ≤ 0.001 | - | - |
| 20-29 | 997 (6.21) | 6,817(93.79) | 7,814 (100.00) | ≤ 0.001 | 1.68 | 1.37 – 2.03 |
| 30-39 | 709 (4.42) | 4,185 (95.58) | 4,894 (100.00) | ≤ 0.001 | 1.93 | 1.58 – 2.36 |
| 40-49 | 253 (1.58) | 1,389 (98.42) | 1,642 (100.00) | ≤ 0.001 | 2.08 | 1.65 – 2.61 |
| ≥50 | 31 (0.19) | 166 (99.81) | 197 (100.00) | = 0.001 | 2.13 | 1.39 – 3.26 |
| **Total** | **2111 (13.15)** | **13,938 (86.85)** | **16,049 (100.00)** | [redacted] | | |

**4.8 Prevalence of BTTIs among Age Groups of Blood Donors by Study Sites.**

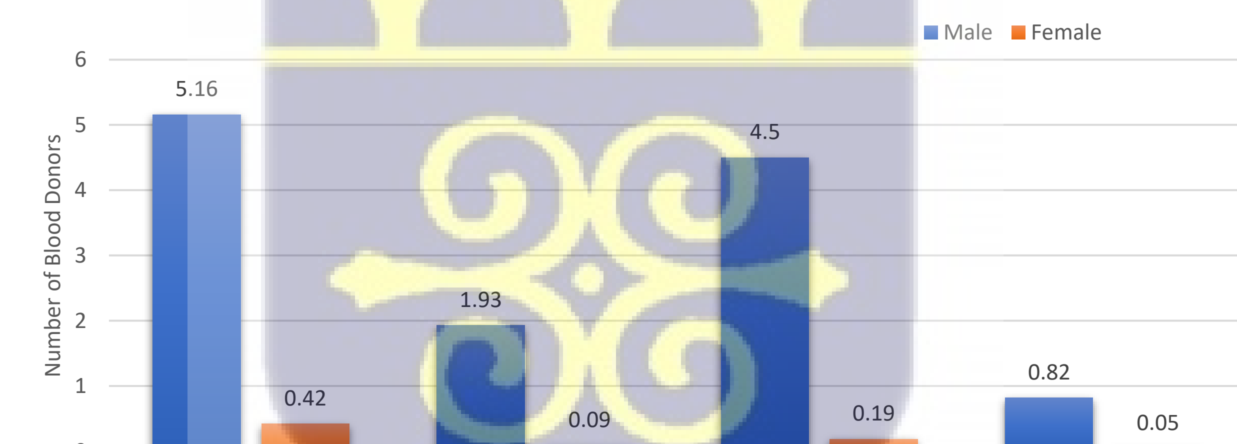
Table 4.6 shows the prevalence of blood transfusion transmissible infections among the various age groups of blood donors at the four study sites in the Western region of Ghana from 2020 to 2023. At St. Martin de Porres Hospital, the study found a statistically significant difference in BTTIs prevalence across age groups ($P \leq 0.001$), with the highest percentage of positive BTTIs in the age groups 20 - 29 years (5.13%) and 30 - 39 years (4.50%). At Axim Government Hospital, the study found the largest group of positive BTTIs in the blood donors in the age groups 20 - 29 years (20.38%), followed by 30-39 years (12.08%). The P-value of 0.43 indicates that the difference across age groups of blood donors was not statistically significant. At Efia Nkwanta Regional Hospital, the study found no statistical difference in BTTIs across the age groups of blood donors ($P > 0.421$), with the highest percentage of positive BTTIs found in the ≤ 20 age group (1.42%) and 20 - 29 age group (1.45%). At Half Assini Government Hospital, the study found a statistically significant difference in BTTI prevalence across the age groups of blood donors ($P = 0.002$), with a higher percentage of positive BTTIs again found in the age groups 20 - 29 (1.08%) and 30 - 39 (1.41%), respectively.

**Table 4.6 Prevalence of Blood Transfusion Transmissible Infections among The Age Groups of Blood Donors by Study Sites.**

| Age Group (years) | ≤ 20 | 20-29 | 30-39 | 40-49 | ≥ 50 | Total | P-value |
|---|---|---|---|---|---|---|---|
| **St. Martin de Porres Hosp. (2020-2023)** | n (%) | n (%) | n (%) | n (%) | n (%) | n (%) | |
| **No. of Negative BTTIs** | 204(2.60) | 3,360(42.85) | 2,446(31.20) | 817(10.42) | 83 (1.06) | 6,910(88.13) | ≤ 0.001 |
| **No. of Positive BTTIs** | 31(0.40) | 402(5.13) | 353(4.50) | 128(1.63) | 17(0.22) | 931(11.87) | |
| **Total Donors Screened** | 235(3.0) | 3,762(48.00) | 27,99(35.70) | 945(12.05) | 100(1.28) | 7,841(100) | |
| **Axim G'vt. Hosp. (2020-2023)** | | | | | | | |
| **No. Negative BTTIs** | 53 (2.07) | 789 (30.86) | 530 (20.73) | 168(6.57) | 28 (1.10) | 1,568(61.32) | |
| **No. of Positive BTTIs** | 36(1.41) | 521(20.38) | 309(12.08) | 112(4.38) | 11(0.43) | 989(38.68) | 0.423 |
| **Total Donors Screened** | 89(3.48) | 1,310(51.23) | 839(32.81) | 280(10.95) | 39(1.52) | 2,557(100) | |
| **Efia Nkwanta Reg. Hosp. (2020-2023)** | | | | | | | |
| **No. of Negative BTTIs** | 1,059(30.05) | 1,527 (43.33) | 531 (15.07) | 238(6.75) | 44 (1.25) | 3399(96.45) | 0.421 |
| **No. of Positive BTTIs** | 50(1.42) | 51(1.45) | 17(0.48) | 6(0.17) | 1(0.03) | 125(3.55) | |
| **Total Donors Screened** | 1,109(31.47) | 1,578(44.78) | 548(15.55) | 244(6.92) | 45(1.28) | 3,524 (100) | |
| **Half Assini G'vt. Hosp. (2020-2023)** | | | | | | | |
| **No. of Negative BTTIs** | 67 (3.15) | 1,143 (53.74) | 677 (31.83) | 165(7.76) | 11 (0.52) | 2,063(97) | 0.002 |
| **No. of Positive BTTIs** | 2 (0.09) | 23(1.08) | 30(1.41) | 7(0.33) | 2(0.09) | 64(3.00) | |
| **Total Donors Screened** | 69(3.24) | 1,166(54.82) | 707(33.24) | 172(8.09) | 13(0.6) | 2,127(100) | |

### 4.9 Prevalence of BTTIs by sex for the study period 2020 - 2023.

Figure 4.4 shows the prevalence of BTTIs by sex for the study period 2020 - 2023. The study found that male blood donors were more represented compared to female blood donors. From a general point of view, a higher prevalence of HBV, HCV, T. pallidum, and HIV was found in male blood donors at 5.16% (828/16,049), 1.93% (310/16,049), 4.5% (723/16,049) and 0.82% (131/16,049), respectively. While a lower prevalence of HBV, HCV, T. pallidum, and HIV was found in female blood donors at 0.2% (67/16,049), 0.09% (14/16,049), 0.19% (30/16,049), and 0.05% (8/16,049), respectively. The odds ratio of 0.66 was found. This implies that female blood donors have 34% reduced odds of testing positive for BTTIs compared to male blood donors. The P-value ≤ 0.001 and 95% C.I of 0.544 - 0.803 were found, meaning the prevalence of BTTIs was higher in males as compared to females, and this difference is statistically significant.




| | HBV | HCV | T. pallidum | HIV |
|---|---|---|---|---|
| Male | 5.16 | 1.93 | 4.5 | 0.82 |
| Female | 0.42 | 0.09 | 0.19 | 0.05 |

**Figure 4.4: Prevalence of Blood Transfusion Transmissible Infections by sex at the study site for the period 2020-2023. (p-value ≤ 0.001)**

### 4.10 Prevalence of BTTIs Co-Infections among Blood Donors

Table 4.7 shows the prevalence of blood transfusion transmissible co-infections of HBV, HCV, T. pallidum, and HIV among blood donors during the period of the study from 2020 to 2023 at the four study sites in the Western region of Ghana. The study found the prevalence of 0.012%, 0.137%, 0.025%, 0.062%, 0.342%, and 0.162%, of HBV+HIV, HBV+HCV, HIV+HCV, HIV+T. pallidum, HBV+T. pallidum, and HCV+T. pallidum dual co-infections among blood donors, respectively. Among the blood donors, the prevalence of 0.00%, 0.012%, and 0.001% HIV+HBV+T. pallidum, HCV+T. pallidum+HIV, and HBV+HCV+HIV, a triple infection, respectively, were found in the study. The study found the prevalence of 0.025% and 0.001% quadruple co-infection of HBV+HCV+T. pallidum and HBV+HCV+T. pallidum+HIV respectively.

**Table 4. 7 Prevalence of Blood Transfusion Transmissible co-infections among Blood Donors**

| **Co-infections** | | **Male (n)** | **Female (n)** | **Frequency (n)** | **Percentage (%)** |
|---|---|---|---|---|---|
| Dual Co-infection | HBV+HIV | 2 | - | 2 | 0.012 |
| | HBV+HCV | 20 | 2 | 22 | 0.137 |
| | HIV+HCV | 3 | 1 | 4 | 0.025 |
| | HIV+T. pallidum | 9 | 1 | 10 | 0.062 |
| | HBV+T. pallidum | 54 | 1 | 55 | 0.342 |
| | HCV+T. pallidum | 26 | - | 26 | 0.162 |
| Triple Co-infection | HIV+HBV+T. pallidum | - | - | 0 | 0.00 |
| | HCV+T. pallidum+HIV | 2 | - | 2 | 0.012 |
| | HBV+HCV+HIV | 1 | - | 1 | 0.001 |
| Quadruple Co-infection | HBV+HCV+T. pallidum | 4 | - | 4 | 0.025 |
| | HBV+HCV+T. pallidum+HIV | 1 | - | 1 | 0.001 |
| | **Total** | **122** | **5** | **127** | **0.79** |

**4.11 Prevalence of Blood Transfusion Transmissible co-infections among sex and age of blood donors for the period 2020-2023.**

Table 4.8 shows the prevalence of blood transfusion transmissible co-infections by sex and among age groups of blood donors for the period 2020 - 2023. The study found no statistically significant difference in BTTI co-infections by sex, with a P-value = 0.84. Although the study found a higher prevalence of BBTI co-infections among male blood donors (96.10% (122/127)) compared to female blood donors (3.90% (5)). Similarly, no statistically significant association was found between the age group of blood donors and the prevalence of blood transfusion transmissible co-infections, with a P-value = 0.91, but a high prevalence of 52% of BTTIs co-infections was found among the age group 20 - 29 years and 33.07% in the 30 - 39 years age group. The prevalence of co-infections among blood donors was observed to be 2% in the age group of 50 years and older, 6% in those aged 20 years and younger, and 10% in the age group of 40 to 49 years.

**Table 4.8 Prevalence of Blood Transfusion Transmissible Infections co-infections among sex and age of blood donors for the period 2020-2023.**

| Variable | 2-type Co-infection | 3-type Co-infection | 4-type Co-infection | Total | $X^2$ | P-value |
|---|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | | |
| **Sex** | | | | | | |
| Male | 114 (95.80) | 7 (100.0) | 1 (100.00) | 122(96.10%) | 0.35 | 0.84 |
| Female | 5 (4.20) | 0 (0.00) | 0 (0.00) | 5(3.90%) | | |
| **Total** | 119 (100.00) | 7(100.00) | 1(100.00) | 127 (100.00%) | | |
| **Age** | | | | | | |
| ≤ 20yrs | 6 (5.04) | 0 (0.00) | 0 (0.00) | 6(4.72%) | | |
| 20-29yrs | 63 (52.94) | 3 (42.86) | 1 (100.00) | 67(52.76%) | | |
| 30-39yrs | 38 (31.93) | 4 (57.14) | 0 (0.00) | 42(33.07%) | 3.37 | 0.91 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 40-49yrs | 10 (8.40) | 0 (0.00) | 0 (0.00) | 10(7.87%) | | |
| ≥ 50yrs | 2 (1.68) | 0 (0.00) | 0 (0.00) | 2(1.57%) | | |
| **Total** | 119 (100.00) | 7(100.00) | 1(100.00) | 127(100.00 %) | | |

### 4.12 Association between ABO-RH'D' blood group type traits and blood transfusion transmissible infections.

Table 4.9 presents the association between ABO-Rh D blood group types and blood transfusion transmissible infections (BTTIs). Out of the total 16,049 blood donors analysed, an overall prevalence of 13.15% (2111/16049) was recorded for BTTIs. The distribution of prevalence across blood groups showed that 9.21% (1478/16049) of infections occurred among blood group O Rh'D' Positive donors, 1.72% (276/16049) among A Rh'D' Positive donors, 1.44% (232/16049) among B Rh'D' Positive donors, and 0.10% (16/16049) among AB Rh'D' Positive donors. Similarly, the prevalence among Rh'D' Negative groups was 0.50% (81/16049) for O Rh'D' Negative, 0.07% (12/16049) for A Rh'D' Negative, 0.09% (15/16049) for B Rh'D' Negative, and 0.00% (0/16049) for AB Rh'D' Negative donors. Blood group O Rh'D' Positive was used as the reference group because it had the highest prevalence of BTTIs compared to the other blood groups. Donors with A Rh' D' positive blood type had an odds ratio of 0.83, indicating that A Rh' D' positive donors had a 17% lower risk of testing positive for BTTIs compared to the reference group. This association was statistically significant ($p = 0.008$, 95% CI: 0.723–0.951). Blood group B Rh' D' positive donors had an odds ratio of 0.72, reflecting that blood group B Rh' D' positive donors had 28% reduced odds of testing positive for BTTIs compared to O Rh 'D' positive donors. This finding was statistically significant ($p \leq 0.001$, 95% CI: 0.622–0.834). Similarly, AB Rh'D' Positive donors had an odds ratio of 0.50, implying that AB Rh'D' Positive donors had 50% lower odds of testing positive for BTTIs compared to the reference group (p = 0.007, 95% CI: 0.294–0.820).

Among Rh'D' Negative donors, O Rh'D' Negative individuals had an odds ratio of 0.73, indicating 27% reduced odds of testing positive for BTTIs among O Rh'D' Negative donors compared to the reference group (p = 0.007, 95% CI: 0.570–0.916). A Rh'D' Negative donors showed an odds ratio of 0.69, suggesting 31% reduced odds of testing positive for BTTIs among A Rh'D' Negative donors compared to the reference group. However, this finding was not statistically significant (p = 0.170, 95% CI: 0.376–1.188). Likewise, B Rh'D' Negative donors had an odds ratio of 0.87, indicating 13% reduced odds of testing positive for BTTIs among B Rh'D' Negative donors compared to O Rh'D' Positive donors, which was not statistically significant (p = 0.538, 95% CI: 0.490–1.452). For AB Rh'D' Negative donors, an odds ratio of 0.18 was observed, corresponding to an 82% reduced risk of testing positive for BTTIs among AB Rh'D' Negative donors compared to the reference group; however, this result was not statistically significant (p = 0.236, 95% CI: 0.011–3.039).

**Table 4.9 Association between ABO-RH'D' blood group type traits and blood transfusion transmissible infections.**

| VARIABLES | HBV | HCV | T. pallidum | HIV | Total | P-value | OR | 95% CI |
|---|---|---|---|---|---|---|---|---|
| ABO Blood Group Type Traits | n (%) | n (%) | n (%) | n (%) | n (%) | | | |
| O Rh'D' Positive | 586(3.65) | 235 (1.46) | 561 (3.49) | 96(0.60) | 1478(9.21) | - | - | - |
| A Rh'D' Positive | 135 (0.84) | 34(0.21) | 87(0.54) | 20 (0.12) | 276(1.72) | 0.008 | 0.830 | 0.723 – 0.951 |
| B Rh'D' Positive | 107 (0.73) | 38 (0.24) | 70(0.44) | 17 (0.11) | 232 (1.44) | ≤0.001 | 0.72 | 0.622 – 0.834 |
| AB Rh'D' Positive | 10 (0.06) | 3 (0.02) | 2 (0.01) | 1 (0.01) | 16 (0.10) | 0.007 | 0.50 | 0.294– 0.820 |
| O Rh'D' Negative | 40(0.25) | 11(0.07) | 26(0.16) | 4(0.02) | 81(0.50) | 0.007 | 0.73 | 0.570 – 0.916 |
| A Rh'D' Negative | 7(0.04) | 2(0.01) | 4(0.02) | 0(0.00) | 12(0.07) | 0.170 | 0.69 | 0.376 - 1.188 |
| B Rh'D 'Negative | 10(0.06) | 1(0.01) | 3(0.02) | 1(0.01) | 15(0.09) | 0.538 | 0.87 | 0.490 – 1.452 |
| AB Rh'D' Negative | 0(0.00) | 0(0.00) | 0(0.00) | 0(0.00) | 0(0.00) | 0.236 | 0.18 | 0.011 – 3.039 |
| **Total** | 895(5.58) | 324(2.02) | 753 (4.69) | 139(0.87) | 2111(13.15) | | | |
| Firth logistic regression<br>**Constance**:0.166 | | | | | | ≤ 0.001 | 0.166 | 0.157 - 0.176 |

# CHAPTER FIVE

# DISCUSSION

## 5.1 Descriptive Statistics of Socio-demographic Characteristics

The data collected from donor screening registers at four selected study sites in the Western Region of Ghana revealed a significant gender imbalance among blood donors. An analysis of the data from 16,049 donors showed that 91.72% were males, while only 8.28% were females. This finding aligns with earlier studies that have reported similar findings in blood donation and transfusion (Aliyo et al., 2022; Heiligenberg et al., 2012; Legese et al., 2022; Melku et al., 2021; Walana et al., 2023). The finding can be linked to the existence of some sociocultural bias in African society, where males are seen to be superior and brave compared to their female counterparts, and hence it is bestowed on males in the society to donate blood in times of need, compared to the female sex (Adu-Poku et al., 2020 and Altayar et al., 2022). Again, some naturally occurring biological cycles in the female sex, like pregnancy, menstrual flow, breastfeeding, miscarriage, exposure to blood transfusion due to lower haemoglobin levels and being much more exposed to surgery compared to the male counterpart, disqualify the female sex during a pre-blood donation screening (Adu-Poku et al., 2020; Aklil & Temesgan, 2022; Altayar et al., 2022; Walana et al., 2023). The study also found that many of the blood donors were between 20 - 29 years (48.69%) and 30 – 39 years (30.49%). This finding was consistent with other studies, and this was due to the financial benefit attached to commercial donation, attracting blood donors in this age bracket to donate blood for socio-economic gains. These commercial donors often withhold crucial information about their medical history or may be willing to lie or omit important details to increase their chances of being accepted to donate blood. These donors are mostly Junior High School and Senior High School leavers (Aliyo et al., 2022; Alumato et al., 2016; Ampofo et al., 2002; Center, 2021; Chaurasia et al., 2014; Heiligenberg et al., 2012; Melku et al., 2021). The fewest blood donors were found in the age group of 50 years and above. This age category from other studies has been reported to be the least in society who visit hospitals to donate blood (Alumato et al., 2016; Ampofo et al., 2002).

### 5.2 ABO – Rh Blood Groups in The Western Region of Ghana

The ABO-Rh blood group most frequently observed among blood donors in the Western Region across the four study sites during the study period was O Rh'D' Positive, accounting for 64.60% of the total. Conversely, the least common blood group was AB Rh'D' Negative, at just 0.10%. Blood group O consistently emerged as the most predominant type, while blood group AB was identified as the least common at each study site. These findings highlight the need to promote mass blood donation at the four study locations to save the lives of recipients with the least prevalent blood group in the Western region of Ghana.

Additionally, the results align with findings from other studies conducted in Saudi Arabia that aimed to determine the predominant ABO-Rh blood group traits among blood donors (Alabdul Monem et al., 2020). A multi-centre study conducted in Ghana, which involved several hospitals, reported similar findings. The hospitals included Nkwanta South Municipality Hospital in the Oti region, Weija-Gbawe Municipal Hospital in the Greater Accra region, SDA Hospital in the Northern region, and Wa Municipal Hospital in the Upper West region (Walana et al., 2023).

One might wonder why blood group O is the most common blood group in our region. The recessive nature of the blood group O allele contributes to its global prevalence. Some theories suggest that the distribution of blood group O is influenced by both genetic and environmental factors, particularly those related to migration. Genetically, blood group O is determined by a recessive allele, meaning that both parents must pass down an O gene for their child to have this blood type, regardless of their blood group. Certain environmental factors that trigger human migration patterns have played a significant role in the widespread occurrence of blood group O around the world (Gylmiyarova et al., 2018; Melese Abate et al., 2016; Mourant et al., 1976; Kopec & Domaniewska-Sobczak,1976).

### 5.3 The Periodic Prevalence Trend of Blood Transfusion Transmissible Infections by Study Sites

At Axim Government and St. Martin de Porres Hospital, the higher stationary linear periodic prevalence trend of blood transfusion-transmissible infections (BTTIs) ($p \leq 0.001$) is associated with a greater prevalence of HBV, HCV, and T. pallidum infections among blood donors in that geographical area. This suggests a significant risk of recipients contracting infections associated with blood transfusions. In contrast, a lower stationary periodic prevalence trend was observed at Effia Nkwanta Regional Hospital and Half Assini Government Hospital. The study did not investigate the reasons for this stationary temporal periodic prevalence trend at these sites due to the limitations of the study design used. The variations in stationary linear periodic trends across different study locations indicate unique health challenges at each site. This highlights the need for tailored interventions. For example, there should be a stronger emphasis on adhering to blood transfusion guidelines, following strict standard operating protocols, providing ongoing training for blood bank staff, and raising public awareness about BTTIs. Additionally, it is essential to encourage these sites to employ ELISA and PCR tests, which have higher sensitivity and specificity, for screening blood samples from donors, since these purposively selected sites have a high number of blood donors screened yearly, instead of relying on rapid diagnostic test kits (RDTs) that are more likely to produce false positives and false negatives. While the study offered valuable facility-specific insights, the proximity and shared population characteristics of the four hospitals may have minimised observable variations in

BTTI prevalence. Future studies could expand to other regions of Ghana to provide a broader epidemiologic comparison.

### 5.4 The Periodic Prevalence Trend of HBV, HCV, VDRL, and HIV Infection in The Western Region of Ghana.

From 2020 to 2023, a general decrease in the periodic prevalence trends of HBV, HCV, T. pallidum, and HIV were observed in the Western Region of Ghana. The very low decrease in HIV prevalence likely indicates effective HIV screening in blood donors. However, the lack of statistical significance in 2022 and 2023 suggests that any further reductions may be more difficult to achieve, possibly due to the very low initial prevalence. A similar trend was found in some studies in determining the prevalence of transmissible infections among blood donors in India and Eastern Ethiopia (Melese Abate & Tesfaye Wolde, 2016; Thakur, 2023). The decreasing trends across all infections may indicate improvements in blood transfusion safety or public health awareness. Continued monitoring and investment in advanced diagnostic technologies, such as PCR and highly sensitive screening tools like ELISA, will be essential to sustain and further reduce the prevalence of HBV, HCV, and T. pallidum infections in the region.

### 5.5 Prevalence of HIV, HBV, HCV, and T. Pallidum among Blood Donors in The Western Region of Ghana

The present study showed an overall prevalence of blood transfusion–transmissible infections (BTTIs) of 13.15% among blood donors in the Western Region of Ghana. This prevalence is higher than that reported in a study conducted in Northwestern Ethiopia (5.4%) but lower than the 21.0% reported in a multicentre Ghanaian study spanning several regions (Legese et al., 2022; Walana et al., 2023). These findings underscore regional variations in transfusion-transmissible infection burdens, which may be influenced by differences in screening practices, population characteristics, and local public health interventions.

In the 21st century, despite the availability of vaccines against the hepatitis B virus (HBV), a major cause of cirrhosis and hepatocellular carcinoma, the infection is still prevalent. The current study found HBV prevalence ranging from 0.5% at Effia Nkwanta Regional Hospital (Takoradi) to 3.05% at St. Martin de Porres Hospital (Ellembelle District), with an overall prevalence of 5.8% among blood donors in the region. This aligns closely with findings by Walana et al., (2023), who reported an overall HBV prevalence of 6.6% across multiple Ghanaian facilities, and contrasts with the higher prevalence of 13.2% reported in the Eastern Region (Alumato et al., 2016). The variation across regions may reflect differences in vaccination coverage, donor education, and community-level risk exposures.

For hepatitis C virus (HCV), the study saw a prevalence range from 0.03% at Half Assini Government Hospital to 1.09% at Axim Government Hospital, with an overall regional prevalence of 1.89%. This is considerably lower than the 8.0% reported in Koforidua (Alumato et al., 2016) and the 4.9% national average reported by Walana et al. (2023), which ranged between 0.2% and 7.7% across sites. The relatively low HCV prevalence among donors in the Western Region may suggest effective donor screening and community-level awareness. However, residual risk cannot be entirely ruled out due to the asymptomatic nature of chronic HCV infection.

About *Treponema pallidum* (the causative agent of syphilis), the study recorded prevalence values ranging from 0.08% at Half Assini Government Hospital to 2.93% at Axim Government Hospital, with an overall prevalence of 4.15% in the Western Region. This rate is lower than that reported by Walana et al. (2023), who found *T. pallidum* prevalence rates of 5.2% in Weija-Gbawe and 13.5% in Nkwanta South, yielding an overall rate of 9.3**%**. The observed difference may reflect regional variations in sexual health education, testing coverage, and adherence to infection prevention protocols among potential donors.

In the case of HIV, the current study found an overall prevalence of 0.74%, ranging from 0.08% at Effia Nkwanta Regional Hospital to 0.38% at St. Martin de Porres Hospital. This is notably lower than the national HIV prevalence of 1.6%, which varies from below 1% to 2.8% across Ghanaian regions, with the Western Region reporting 2.7% among the general population (Ali et al., 2019). These findings suggest that HIV prevalence among blood donors is approximately 27.4% of the general population burden, indicating that blood donors constitute a relatively low-risk population, possibly due to pre-donation screening protocols and self-selection among healthy volunteers.

Overall, the observed prevalence patterns for HBV, HCV, *T. pallidum*, and HIV highlight important inter-district variations and emphasise the need for strengthened donor education, enhanced screening fidelity, and targeted prevention strategies to further reduce transfusion-associated infection risks in the Western Region.

### 5.6 Prevalence of HIV, HBV, HCV, and T. Pallidum Co-infections among Blood Donors in The Western Region of Ghana

The prevalence of blood transfusion-transmissible co-infections among blood donors in the Western Region of Ghana was found to be 0.79%. In contrast, a study conducted in Koforidua reported a higher prevalence of 2.35% among blood donors. This indicates that the co-infection rate in the Western Region was lower than that in the Eastern Region (Alumato et al., 2016).

The most prevalent co-infection among blood donors was HBV+T. pallidum, this was consistent with findings from similar studies (Alumato et al., 2016; Walana et al., 2014). This was followed by HCV + T. pallidum, HBV + HCV and HIV + T. Pallidum. The least common co-infections were HBV + HCV + HIV and HBV + HCV + T. pallidum + HIV. All co-infection types were observed except for HIV + HBV + T. pallidum. However, unlike prior research, the current study in the Western Region identified both triple and quadruple co-infections. These findings align with studies from Koforidua and Kintampo Municipal Hospitals, which also reported HBV + T. pallidum as the predominant co-infection among blood donors (Alumato et al., 2016; Walana et al., 2014). No statistically significant association was found between co-infections and age (P = 0.9) or sex (P = 0.84). However, co-infections were most prevalent among donors aged 20-29 years, with male donors representing the majority of co-infected individuals. Similar international studies in China and the USA found T. pallidum often co-infecting with HIV and other pathogens, reinforcing the findings of this study (Blocker et al., 2000; Gong et al., 2020). Interestingly, while *HIV + T. pallidum* co-infection predominates in studies from the United States, the present study observed HBV + *T. pallidum* as the leading co-infection pattern. This divergence likely reflects epidemiological, behavioural, and health care system differences between the two settings. In Ghana, HBV is highly endemic, with transmission occurring mainly through perinatal, horizontal, and unsafe injection routes, while *T. pallidum* is primarily sexually transmitted. Conversely, in the United States, HBV endemicity is low, HBV vaccination coverage is high, and sexual transmission networks, particularly among high-risk groups such as MSM, drive *HIV + T. pallidum* co-infection patterns. Furthermore, differences in donor population structure (replacement versus voluntary donors) and testing methodologies (RDTs versus ELISA/NAT) may partly explain the regional variation in co-infection detection.

HBV, HCV, T. pallidum, and HIV share the same transmission routes, which helps explain the co-occurrence of these infections. T. pallidum is commonly transmitted sexually, especially among individuals engaging in high-risk behaviours, which increases susceptibility to other infections like HIV, HBV, HCV, and VDRL (Alter, 2006; Karp et al., 2009; Peterman et al., 2015).

HIV and T. pallidum co-infections are common due to T. pallidum-induced genital ulcers, which breach the mucosal barrier, facilitating HIV entry. Additionally, these ulcers attract CD4+ cells, creating a favourable site for HIV, thereby increasing transmission risk (Karp et al., 2009). This mode not only aids in the successful passage of HIV infections but also facilitates the passage of other infections like HCV, HBV, and more into the host. The prevalence of HIV, HBV, and T. pallidum co-infections with HCV has been linked to shared risk factors, such as using shared shaving blades, needle-sharing among injection drug users, and unsafe sexual practices involving multiple partners (Shrestha et al., 2012).

### 5.7 The Relationship between Socio-Demographic Characteristics and Transfusion Transmissible Infections among Blood Donors

The overall prevalence of blood transfusion-transmissible infections (BTTIs) was found to be 13.15%, with a higher prevalence among males (12.41%) compared to females (0.74%). Female donors exhibited 34% reduced odds of testing positive for BTTIs than their male counterparts (95% CI = 0.544–0.803, P-value ≤ 0.001). It was observed that male blood donors recorded a higher prevalence of HBV, HCV, T. pallidum, and HIV compared to female blood donors. In many studies in Ghana, it has also been reported that males are much more exposed to blood-transfusion-transmissible infection compared to females (Altayar et al., 2022; Walana et al., 2023). The finding also aligns with existing research that underscores how socio-behavioural factors impact BTTI risk, particularly among males' sex. Heiligenberg et al. (2012) highlight certain behaviours, such as having multiple sexual partners, MSM, and engaging in unprotected sex, which significantly heighten the risk of BTTIs being predominant among males in society.

Furthermore, additional studies have indicated that high-risk practices, such as sharing unsterilized drug paraphernalia and using non-sterile tattooing tools, significantly increase the risk of Bloodborne Transmissible Infections (BTTIs). These risky behaviours are especially common in high-risk populations, including commercial sex workers and individuals with multiple sexual partners (Duda et al., 2005; Jafri et al., 2006; Walana et al., 2023).

This study's analysis reveals a statistically significant association between age and blood-transfusion-transmissible infections, indicating that growing older is an indicator of increased odds for these infections (P-value ≤ 0.001). Younger donors aged 20 years and younger exhibited the lowest prevalence of BTTIs, while donors in the 20 – 29 age group showed a higher prevalence that continued to rise with age, peaking among donors aged 50 years and older.

Interestingly, although there is a slight decline in the absolute prevalence of BTTIs in individuals aged 50 years and over, the odds ratios suggest a persistent age-dependent risk factor for BTTIs. Numerous studies support this association, demonstrating that higher risks of BTTIs correlate with socio-behavioural factors and prolonged exposure to risky behaviours that accumulate with age, with prevalence often being concentrated in individuals under 40 years (Aliyo et al., 2022; Alumato et al., 2016; Heiligenberg et al., 2012; Legese et al., 2022; Melku et al., 2021).

Additionally, older adults face greater exposure to risk factors over time, such as surgical procedures, blood transfusions, and high-risk behaviours linked to infections like HIV, HBV, HCV, and T. pallidum, which cumulatively elevate the likelihood of BTTIs (Busch & Satten, 1997; Candotti & Allain, 2009). Further research indicates that ageing can affect the immune system's efficiency, which increases susceptibility to infections, including BTTIs. Older adults may not clear infections as effectively as their younger counterparts (Pawelec, 2018), thereby prolonging the duration of infection and potentially increasing the likelihood of detection during blood donor screening. This immunosenescence, coupled with cumulative exposure to infection risk factors over time, may partly explain the higher prevalence of BTTIs observed among older donors in this study.

### 5.8 The Relationship Between ABO-Rh Blood Group Traits and Blood Transfusion-Transmissible Infections Among Blood Donors.

In this current study, it was found that the O Rh'D' Positive blood group had the highest prevalence of blood transfusion-transmitted infections (BTTIs) compared to other ABO Rh'D' blood groups. In contrast, the AB Rh'D' Negative blood group showed no detected cases of BTTIs. A similar study found a higher prevalence of transfusion-transmissible infections, including HBV, HCV, T. pallidum, and HIV, among O Rh'D' Positive individuals. It also noted that there were no detected cases of BTTIs among AB Rh'D' Negative individuals (Melese Abate et al., 2016).

This can be attributed to the predominance of O blood groups in the geographical area, while AB blood groups are the least common. Therefore, it is expected that there will be more positive test results for BTTIs among O blood groups, while AB blood groups are expected to show the least positive results for BTTIs. A higher prevalence of infection among individuals with O Rh'D' Positive blood type may be linked to increased exposure to high-risk factors, including unsafe sexual practices, contact with infected blood, mother-to-child transmission during birth, and receiving infected blood transfusions. These factors significantly elevate the risk of contracting blood-transfusion-transmissible infections(Gong et al., 2020). This finding may also be attributed to the fact that blood group O lacks antigens and expresses only the H-antigen precursor on the surface of all red blood cells. As a result, individuals with blood group O may be more susceptible to contracting infections that are transmissible through blood transfusions compared to those with other ABO blood groups (Altayar et al., 2022; Cooling, 2015; Legese et al., 2022; Yang et al., 2022).

The relationship between ABO-Rh blood groups and blood transfusion transmissible infections among blood donors has been investigated by scholars globally, but with limited research in our region. The current research conducted investigated the association between BTTIs (HBV, HCV, T. pallidum, and HIV) and ABO-Rh 'D' blood group. Several studies conducted have shown that there was no statistically significant association between ABO-Rh 'D' and BTTIs. While others show a statistically significant association between ABO-Rh 'D' and BTTIs (Patel et al., 2022; Legese et al., 2022; Tyagi et al., 2013; Yang et al., 2022).

The current study established an association between ABO-Rh D blood groups and blood-transfusion transmissible infections. The study found a statistically significant reduction in the odds of BTTIs for several ABO blood groups compared to the reference blood group, O Rh'D' Positive (P-value $< 0.005$). Specifically, an increasing odds of protectiveness against susceptibility to BTTIs among ABO-Rh 'D' blood groups were found in this order: AB Rh' D' Positive > O Rh 'D' Negative > B Rh 'D' Positive > A Rh 'D' Positive ($p \leq 0.008$). However, other blood groups, particularly A, B, and AB Rh 'D' Negatives, showed a significant association with reduced odds of BTTI risk, but the findings were not statistically significant ($p > 0.050$). This finding was not different from what was found in a study conducted in the Western Region of Saudi Arabia among blood donors, with findings being consistent with the current study, where O Rh'D' Positives of developing BTTI infections than the other blood group types with AB blood groups, the AB Rh'D' positives have a higher protective effect or at lesser risk of developing BTTIs (Altayar et al., 2022).

### 5.9 Limitation

This study is limited by its reliance on the accuracy and completeness of existing hospital records, which may have varied in quality across the participating facilities. Such inconsistencies could have affected data accuracy and, consequently, the robustness of the findings. Although the retrospective cross-sectional design was suitable for achieving the study objectives, it captured data at a single moment in time, thereby restricting causal inference and offering only a snapshot of the trends in blood transfusion-transmissible infections (BTTIs).

Furthermore, the study was based on data obtained from four purposively selected health facilities within the Western Region of Ghana, which introduces potential selection bias and limits the generalisability of the findings to the broader population of blood donors in the region. The retrospective nature of data collection also constrained control over certain operational or documentation errors that might have occurred during routine blood donor screening.

Additionally, the study did not include key socio-behavioural and clinical variables such as occupation, education, marital status, and donor history (first-time versus repeat donors), which could have provided deeper insights into the determinants of BTTTS. These omissions restrict the study's capacity to explore behavioural and demographic predictors of infection.

Despite these limitations, the study design remains appropriate for assessing prevalence patterns and identifying associations between donor characteristics and transfusion-transmissible infections. The findings thus offer valuable baseline information that can guide policy development, strengthen blood safety surveillance, and inform future longitudinal studies in the region.

# CHAPTER SIX

## 6.0 CONCLUSION

This study demonstrated that blood transfusion-transmissible infections (BTTIs) remain a major public health concern among blood donors in the Western Region of Ghana. Viral infections, particularly hepatitis B virus (HBV) and bacterial infections, particularly *Treponema pallidum* (syphilis), were the most frequently encountered, followed by hepatitis C virus (HCV) and HIV. Although co-infections were relatively rare, their presence underscores the ongoing risk of transfusion-transmitted diseases and the need for rigorous donor screening and surveillance.

The study identified clear demographic and serological patterns associated with BTTIs. Older donors and males were more at risk of testing positive, suggesting that cumulative exposure and behavioural factors may contribute to infection risk. In addition, blood-group distribution appeared to influence infection occurrence. Donors with blood group O Rh D positive exhibited higher odds of testing positive compared with other blood groups. While this relationship may be partly attributable to the predominance of group O in the general population, it also raises important questions about potential biological or epidemiological links that warrant further investigation.

Overall, these findings emphasise the importance of continuous surveillance and periodic review of donor-screening outcomes to identify changing trends in transfusion-transmissible infections. Strengthening laboratory quality systems, ensuring adequate staffing, and confirming all reactive screening results are vital to maintaining the integrity of blood transfusion services and improving donor safety.

At both national and facility levels, transfusion programs should intensify education on safe blood donation, promote voluntary non-remunerated donor recruitment, and strengthen collaboration among laboratory, clinical, and public health teams. Future research should employ prospective and molecular approaches to better understand infection dynamics, explore possible associations between blood-group antigens and pathogen susceptibility, and inform targeted interventions to enhance transfusion safety in Ghana.

## 6.1 Recommendations

### A. To the four Hospitals:

1. **Improve Data Capture and Record-Keeping Systems**

   The study found inconsistencies and missing data across donor registers, which could compromise surveillance accuracy. Therefore, blood donor registers should be updated to include other demographic variables such as occupation, educational level, and marital status. Routine verification of donor data by the Blood Bank Manager at the end of each shift will enhance the completeness and integrity of the data risk factors for blood transfusion–transmissible infections.

2. **Strengthen Screening and Diagnostic Capacity**

   Since HBV and *T. pallidum* were the most prevalent infections among donors, it is recommended that all donated blood be rescreened for BTTIs before cross-matching for transfusion. Furthermore, the Regional Blood Service Coordinator and hospital laboratories should gradually transition from rapid diagnostic tests (RDTs) to enzyme-linked-immunosorbent assay (ELISA) in high-volume facilities. This shift is justified by the need for greater test sensitivity and specificity, as shown by the persistent HBV seropositivity rates in the study.

**3. Implement Structured Referral and Follow-Up for Reactive Donors**

The study revealed that some donors tested positive for HIV, HBV, HCV, and *T. pallidum*. These individuals should be promptly referred to the Public Health Unit for confirmatory testing, counselling, and treatment, following national HIV and hepatitis protocols. This will reduce the likelihood of re-donation by infected individuals and enhance community health outcomes.

**B. To the Western Regional Health Directorate:**

1. **Intensify Public Health Education and Community Engagement**

The study found higher HBV and *T. pallidum* prevalence in districts such as Ellembelle and Axim. The Deputy Director of Public Health should therefore prioritise targeted health education campaigns in these districts to promote HBV vaccination, safe sexual practices, and voluntary non-remunerated blood donation.

2. **Upgrade Laboratory Infrastructure and Surveillance Systems**

To ensure consistency in screening quality across facilities, the Regional Director of Health Services (RDHS) and the Regional Blood Service Coordinator should strengthen regional surveillance mechanisms and enforce periodic quality audits of blood screening processes. Improved data linkage between hospitals and the regional health directorate will help early detection of infection trends and inform prompt interventions.

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# APPENDIX

## I

An extraction log generated in Microsoft Excel 2021

| ID | age | sex | bldgrp | rhd | hbv | hcv | vdrl | hiv |
|---|---|---|---|---|---|---|---|---|
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# APPENDIX

## II

Data Extraction Log

| S/N | Variable | Label | Label Value |
|---|---|---|---|
| 1 | IDNUM | Data Extraction Identification Number | #### |
| 2 | District | District of Location of Hospital Blood Bank | |
| 3 | Facility | Hospital Blood Bank name data is extracted | |
| 4 | Age | Age in complete years of Blood Donor | #### |
| 5 | Sex | Sex of Blood Donor | 1=male, 2=female |
| 6 | Blood Group | Blood group trait of Blood Donor | 1=O, 2=A, 3=B,4=AB |
| 7 | Rh 'D' | Rhesus factor 'D' of Blood Donor | 6=negative, 1=positive |
| 8 | HBV | Hepatitis B Viral infection status of Blood Donor | 6=negative, 1=positive |
| 9 | HCV | Hepatitis C viral infection Status of Blood Donor | 6=negative, 1=positive |
| 10 | VDRL | *Treponema pallidum* (syphilis) | 6=negative, 1=positive |
| 11 | HIV | Human Immunodeficiency Viral infection status of Blood Donor | 6=negative, 1=positive |
| | | | |

# APPENDIX

# III

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

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

*My Ref. GHS/RDD/ERC/Admin/App/24/318*
*Your Ref. No.*

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Digital Address: GA-050-3303
Mob: +233-50-3539896
Tel: +233-302-960628
Email: ethics.research@ghs.gov.gh
8th July 2024

Darren Enchill Hall
Department of Epidemiology and Disease Control
School of Public Health
Legon

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

| | |
|---|---|
| GHS-ERC Number | **GHS-ERC: 054/05/24** |
| Study Title | Prevalence and Factors Associated with Blood Transfusion-Transmissible Infections among Blood Donors in the Western Region of Ghana |
| Approval Date | 8th July 2024 |
| Expiry Date | 7th July 2025 |
| GHS-ERC Decision | **Approved** |

**This approval requires the following from the Principal Investigator**

- Submission of a 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.

**You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19**

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.............................................................
Mr. Kofi Wellington
(GHS ERC Chairperson)

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

# APPENDIX

## IV

**GHANA HEALTH SERVICE**

REGIONAL HEALTH DIRECTORATE – WESTERN REGION

P. O. Box 202, Sekondi
Digital Address: WS-001-9795
E-mail: rdhs.wr@ghs.gov.gh
Tel. No. :0551111148
Quote this number and date on all correspondenc
My Ref. No. GHS/ WRHD/ DDA / 09-CL4 /24
Your Ref. No.
Date. 16th SEPTEMBER. 2024

**MEDICAL DIRECTOR, ENRH**

**MEDICAL SUPERINTENDENTS:**

- **AXIM GOVERNMENT HOSPITAL**
- **HALF ASSINI GOVERNMENT HOSPITAL**
- **ST. MARTIN DE PORRES HOSPITAL**

**INTRODUCTORY LETTER**

**HALL DARREN ENCHILL**

This serves to inform you that the above-named student of the University Of Ghana has been granted permission to access information in your facility to complete his research work as indicated in the attached letter.

Kindly accord him the needed assistance to enable him to complete his data collection.

Thank you.

**DR. YAW OFORI YEBOAH**
**REGIONAL DIRECTOR OF HEALTH SERVICE**
**WESTERN REGION**