PREVELENCE AND CORRELATES OF HEPATITIS B VIRUS INFECTION AMONG HEALTH CARE WORKERS IN KISUMU COUNTY, KENYA: CROSS-SECTIONAL STUDY

FRANKLINE OTIENO MBOYA

A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of Master of Science in Biomedical Science and Technology of Jaramogi Oginga Odinga University of Science and Technology.

© 2024

DECLARATION

Declaration by the Candidate.

I declare that this is my original work and no part of it has been presented in any University for any award. No part of this proposal may be reproduced without a written permission.

Frankline Otieno Mboya

Admin number: H153/4268/2015

Sign……... Date……

Declaration by the University Supervisors:

This thesis has been submitted for examination with our approval as university supervisors.

Dr. Daniel Onguru
Department of Biomedical Sciences,
School of Health Sciences,
Jaramogi Oginga Odinga University of science and Technology.

Signature..... Date.....

Dr. Daud Ibrahim. PHD.
Laboratory Director,
United States Army Research Directorate-Africa.

Signature..... Date.....

ABSTRACT

Health care services in hospitals restore health and save life, they also produce medical waste which if poorly managed poses risk to health care workers (HCWs) through contacts and needlestick injuries. Hospital occupational exposure is a potential source of pathogens of global health concerns like Hepatitis B virus (HBV). HBV infection increases risk of death from liver cirrhosis and cancer. Globally, about 2 billion people have evidence of past or present HBV infection, and 240 million are chronic carriers. Pooled prevalence of HBV infection among HCWs in Kenya is 6.8 %, while the prevalence in general population is 2-5% with about 31% of people being previously exposed. Due to the unknown magnitude and risk factors of HBV infection among HCWs in Kisumu, this descriptive cross-sectional study was conducted to investigate the prevalence and correlates of HBV infections among HCWs; determine prevalence of Hepatitis B surface antigen (HBsAg), total hepatitis B core antibody (anti-HBc) and hepatitis B surface antibody (anti-HBs); determine HBV infection risk factors, needle stick injury, contact exposure, HBV immunization status and uptake, infectious waste segregation and disposal, Personal Protective Equipment (PPE) availability and adequacy; determine number of HCWs who have been trained on usage of PPEs, infectious agent on waste, waste management and determine the relationship between HBV infection verses sociodemographic and risk factors among HCWs. A sample size of 192 was selected from total 823 HCWs. Structured questionnaire was used to collect demographic and risk factors information. From each consenting participants, 4.0ml of blood was collected to determine participants HBV sero-status. Testing for HBsAg, anti-HBc and anti-HBs biomarkers were done serially using enzyme immunoassay (EIA) method at Kenya medical Research Institute-Human Immunodeficiency Virus Research Laboratory. Participant median age was 34.4 years with interquartile range of 11(28-39) years, majority were male 52.1% and 78.7% of participants were married. Among the 192 HCWs in this study, prevalence of HBV infection (positive for HBsAg) was 36 (18.8%), prevalence of anti HBc (developed immunity because of natural infection) was 49 (25.5%) and prevalence of anti HBs (developed immunity after vaccination) was 72 (37.5%). There were 34 (17.7%) susceptible HCWs (never infected and had no evidence of immunization). Higher prevalence of HBV infections at 37.5% and 35.9% was found in HCWs who had worked for less than one year and those who had not received any dose of HBV vaccine respectively. Among the HCWs, 47.4% and 5.7% had needle stick injury and contact exposure at workplace. PPEs availability and adequacy at 90.6 and 22.4 respectively. Medical waste was not adequately segregated and incinerated at 29.7% and 67.2% respectively. Significant risk of exposure to HBV infection was found among HCWs with one vaccine dose and those with no known exposure. HCWs who had received ≥2 doses of HBV vaccine (aOR, 0.03; 95% CI, 0.01-0.10, p-value= <0.0001) had significant HBV protection. Prevalence of HBsAg and anti HBc among HCWs in this study was about 6 and 5-fold higher than general population, this could be attributed to high needle stick injury contact exposure and low vaccination coverage. There should be increased surveillance on HAI like HBV infections to identify and refer infected HCWs for clinical management, more sensitization is required on HBV vaccination to improve HBV vaccine uptake among HCWs. Additional studies are required to determine effect of HBV vaccine availability on vaccine coverage and uptake; causes, effects, and prevalence of isolated anti-HBc among healthcare workers and clustering pattern of HBV infections among HCWs.

ACKNOWLEDGEMENT

I would wish to give thanks and praise to the Almighty God for the precious gift of life, good heath, knowledge, strength, and protection that enabled me reach this far.

It is my humble pleasure to extend my sincere gratitude to my able supervisors, Dr. Daniel Onguru and Dr. Ibrahim Daud, for their unwavering support, dedication, enthusiasm, patience and understanding they exhibited which enabled me to successfully carry out and complete this project.

I acknowledge, appreciate and thank: County Government of Kisumu, JOOTRH Ethics Review Committee (ERC), study hospital's management for allowing us to do this study, Kenya Medical Research Institute, Center for Global HIV Research, HIV Research Laboratory (KEMRI-CGHR HIV-R Laboratory) for performing the laboratory tests for the study, data collectors/laboratory Scientists of each hospital for their assistance in data and sample collection, study subjects who volunteered to participate in this study and lastly Jaramogi Oginga Odinga University of Science and Technology for their mentorship and support in designing and conducting the study.

DEDICATION

This research is dedicated to my wife Mercy Jacodull, and parents David Mboya and Eunice Kisuge. They have genuinely encouraged and supported my educational endeavours, and for that. I will be eternally grateful.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ACRONYMS, ABBREVIATIONS

AIDS	Acquired immunodeficiency syndrome.
CHB	Chronic Hepatitis B
DNA	Deoxyribo-Nucleic Acid
HAI	Hospital Acquired Infections
HBV	Hepatitis B Virus
HCC	Hepato-Cellular Carcinoma
HCV	Hepatitis C Virus
NACOSTI	National Commission for Science Technology and Innovation
HCWs	Health Care Workers
HIV	Human Immunodeficiency Virus
KAIS	Kenya Aids Indicator Survey
KEMRI	Kenya Medical Research Institute
MWH	Medical Waste Handlers
PPE	Personal Protective Equipment
HBsAg	Hepatitis B surface Antigen
anti-HBc	Total hepatitis B core antibody
anti HBs	Hepatitis B surface antibody
EIA	Enzyme immunoassay
CI	Confidence interval
OR	Odds Ratio
aOR	Adjusted odds Ration.

HCS	Health care settings
VL	Viral load
IPC	Infection Prevention and Control
ARVs	Antiretrovirals
TTI	Transfusion transmissible infections
WHO	World Health Organization
PEP	Postexposure prophylaxis
HBIG	Hepatitis B immune globulin
KHIS	Kenya Health Information Systems
OPD	Outpatient department
IPD	Inpatient Department
TB	Tuberculosis
MCH	Maternal Child Health
FP	Family Planning
PPS	Probability proportional to size
EDTA	Ethylene-diamine-tetra-acetic acid
PID	personally identifiable information
KEPI	Kenya Expanded Programme on Immunization
ISO	International organization for standardization

DEFINATIONS OF TERMS

HBV current infection: Individual's blood is serologically positive for HBsAg.

HBV lifetime exposure: Individuals whose blood is serologically positive for either HBsAg (current infection) or anti-HBc (may indicate a current or past resolved infection.

CHAPTER ONE: INTRODUCTION

1.1 Background

Hepatitis B Virus (HBV) infection is a global public health problem with about 2 billion people estimated to have evidence of past or present HBV infection, and 240 million being chronic carriers of Hepatitis B surface Antigen (HBsAg), the highest prevalence >5% noted in sub Saharan Africa, East Asia and Amazon Basin of South America (WHO, 2015) (WHO, 2017). In 2016, mortality due to viral hepatitis was about 1.4 million with 47% of the deaths due to HBV infection (W.H.O, 2019; WHO, 2016). Prevalence of HBV infection in Africa is on average more than 10%, classifying the region as one of high endemic area (Amsalu et al., 2016; Anagaw et al., 2012; Franka et al., 2009).

Modes of HBV transmission is perinatally, through percutaneous and sexual exposures. In health care settings (HCS) occupational exposures occurs through needle or sharp object injury, mucous membrane and non-intact skin (Pruss-Ustun et al., 2005; Terrault et al., 2018).

Hepatitis B vaccination has proven to be a key strategy to prevent infections, the Kenyan Government has a policy where infants are given 1st 2nd and 3rd dose of pentavalent vaccine at 6, 10 and 14 weeks respectively to protect the child from Diphtheria, Pertussis, Tetanus, Hepatitis B and Hib while monovalent hepatitis B vaccine is recommended for most at risk groups like health care workers (HCWs) (Ministry of Health, 2023).

There is low hepatitis B vaccine coverage and insufficient immunity to the virus among HCWs due to uncompleted vaccine dosage coupled with knowledge gaps, inadequate PPE and poor waste management process (Alege et al., 2020; Atlaw et al., 2021; Mwangi et al., 2023). Prevalence of HBV in Kenya is between 3-8%, Human immunodeficiency virus (HIV) disease, blood transfusion and body scarification being potential predictors to HBV infection (Downs et al., 2023; Makokha et al., 2023). HBV is an important occupational hazard to HCWs because of high virulence due to its higher viral load (VL) in the blood, transmissibility in absence of visible blood, its availability in several other body fluids and longer environmental viability (Service, 2001). In HCS, concern is high about HBV infections on HCWs due to strong evidence of occupational exposure to sharps and contact with contaminated

waste (Chartier et al., 2014; Wijayadi et al., 2018). HBV is considered as Hospital acquired infection (HAI) because unvaccinated HCWs could acquire infection through needle stick injury and contacts, this puts them at higher risk than the general populations (Adeyemi et al., 2021; Shindano et al., 2017; Trepo et al., 2014).

In controlling and reducing HBV infection, hazardous waste being reservoir for pathogens requires reliable and safe handling (Ministry of Public Health and Sanitation and Ministry of Medical Services, December 2010). Despite HBV infection being a public health concern globally, in middle and low income countries like Kenya, information about its existence is not well researched, its availability and prevention is not well documented in HCS (Hostiuc et al., 2018).

In Kenya, there is limited information about HBV prevalence among HCWs despite the documentation that about 42.6% of health care workers has had occupational splash, sharps, and needle stick injuries (Ministry of Public Health and Sanitation and Ministry of Medical Services, December 2010; Ongete & Duffy, 2018). The risk of HAI like HBV increases when basic infection prevention and control (IPC) practices in health care settings are not well laid out and adhered to. There is limited data on occupational exposure to HBV infection and its prevalence among HCWs in Kenya.

1.2 Statement of the Problem

Hepatitis B Virus infection is a major public health concern with changing epidemiology due to vaccination policies, practice, and migration. The infection is not curable if it progresses to chronic stage making the effective treatment lifelong, concern of HBV infection is greater among high risk groups like HCWs due to their risk resulting from occupational exposure (European Association for the Study of the Liver. Electronic address & European Association for the Study of the, 2017). In Sub Saharan country like Kenya where the HBV prevalence is high, individual working in hospitals like HCWs remain susceptible to HBV infection and are at greater risk of contracting the virus at their workplace as a result of contact with patients and waste generated at workplace, these individuals could also spread the infections to their family, fellow colleagues and patients (Mueller et al., 2015). Modes of transmission for HBV includes contact and unsafe injection practices like recapping of hollow-bore needles, poor waste segregation and disposal methods, all these are common occurrences in health care settings thus increasing risk if HCWs are unvaccinated

(Allegranzi et al., 2011; Amsalu et al., 2016; Mbaisi et al., 2013). Additionally, risk of HBV infection is due to its high virulence, longer viability in environment, its availability in most body fluids and ability to be transmitted through infected waste, these further puts HCWs at higher risk of acquiring the infection at work setting (Amsalu et al., 2016; Anagaw et al., 2012). Though the Government of Kenya has a policy for pre-employment Hepatitis B vaccination for those at higher risk like HCWs, previous studies has shown low hepatitis B vaccine coverage and insufficient immunity to the virus due to uncompleted vaccine dosage coupled with knowledge gaps, inadequate PPEs and poor waste management process in health care settings (Alege et al., 2020; Atlaw et al., 2021; Mwangi et al., 2023).

There is scarce evidence concerning the prevalence of HBV infection and its correlates among health care workers in Kenya. Understanding the magnitude and correlates of HBV infection among this high-risk population will enlighten policy makers and HCWs on its burden and risks factors, this will bring focus and emphasis that is required to address any gaps that may be identified. This study aims to assess the prevalence and correlates of HBV infection among HCWs in Kisumu County.

1.3 Objectives

1.3.1 Main Objective

To investigate the prevalence and correlates of HBV infections among HCWs in Kisumu County.

1.3.2 Specific Objectives

i. To determine the prevalence of Hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (HBsAb) and hepatitis B core antibody (HBcAb) among HCWs in Kisumu County.
ii. To determine HBV infection risk factors: (i) Needle stick injury and contact exposure among HCWs, (ii) HBV immunization status and vaccine uptake among HCWs in Kisumu County, (iii) Infectious waste segregation and disposal in health care settings, (iv) PPEs availability and adequacy to HCWs.
iii. To determine the number of HCWs who have been trained on: (i) usage of PPEs, (ii) Infectious agent on waste (iii) Waste management.
iv. To determine relationship between the positivity for HBV versus sociodemographic (age, gender, marital status, years of service, cadre) and risk factors (history of needle stick injury and contact exposure, HBV immunization

status and vaccine uptake, waste segregation and disposal methods, PPEs availability, and adequacy.

1.4 Research Questions

i. What is the prevalence of HBsAg, HBsAb and HBcAb among HCWs in selected health facilities in Kisumu County?

ii. What is the level of HBV infection risk factors: (i) Needle stick injury and contact exposure among HCWs, (ii) HBV immunization status and vaccine uptake among HCWs in Kisumu County, (iii) Infectious waste segregation and disposal in health care settings, (iv) PPEs availability and adequacy to HCWs.?

iii. What is the number of HCWs who have been trained on: (i)usage of PPEs, (ii)Infectious agent on waste (iii) Waste management?

iv. What is the relationship between the positivity for HBV versus sociodemographic (age, gender, marital status, years of service, cadre) and risk factors (history of needle stick injury and contact exposure, HBV immunization status and vaccine uptake, waste segregation and waste disposal method, PPEs availability, and adequacy?

1.5 Justification

Documented evidence shows that close to 65.7% of HCWs have had occupational exposure to body fluids, 36.0% of the exposures are due to contact and percutaneous injury this exposes HCWs to HBV infection than the general population (Amsalu et al., 2016; Anagaw et al., 2012; Auta et al., 2017). HCWs are predisposed against HBV infections due to low awareness of HBV serostatus, suboptimal HBV vaccination uptake and low HBV seroprotective rates among HCWs (Mwangi et al., 2023; Tunnage et al., 2021). Despite availability of treatment policies and antiretroviral (ARVs) drugs to treat HBV, the drugs are inaccessible to many HCWs coupled with paucity of data to adequately describing the burden of HBV infections among HCWs in Kisumu County. Surveillance of HBV infection among high-risk populations like HCWs is essential to record the size of this infection and factors that are associated with it among HCWs to enable development and implementation of effective preventive measures to address the gaps. Moreover, by itself, surveillance through studies like this seeking to determine the correlates (prevalence and risk factors) of HBV virus infection which is considered an hospital acquired infection can

lead to reduction in health-care-associated infection through awareness creation and addressing the gaps contributing to the increased risks of HAI.

1.6 Significance of the Study

This study has brought the much-required evidence and data on the burden of HBV infection and highlights risk factors that contributes to the burden of the HBV among the HCW. Evidence from this study, which will be presented to public health officials, decision-makers, and other stakeholders is informative on the burden of HBV infection among HCWs in Kisumu and has recommended prevention measures amenable to HCWs in Kisumu County.

1.7 Limitation of the Study

This study was done in 2021, during this time COVID 19 outbreak was at its peak in Kenya, due to this, there was a lot of fucus on infection prevention to mitigate COVID 19 infections, in as much as this may have influenced the findings on the compliance with training on PPEs, waste segregation and disposal.

Also, during this COVID19 period the government issued recommendations that elderly populations and those with comorbidities should work from home so we may have missed some eligible health care workers at the facilities. Being that this was a crossectional study we missed some eligible health care workers who were off duty and those who were working at night, the study design also did not look if there is any clustering pattern of HBV infection among HCWs or among hospitals. The results from this purposive sample of facilities cannot be generalized across all health facilities nationally and therefore, a national survey covering both public and private facilities would provide a more precise estimate of HBV infections among HCWs in Kenya. We only assessed HBV exposures that are related to health care settings therefore the generalizability is limited to the studied health facility related exposures. Health care workers are not done for thorough pre-employment medical examination so it’s difficult to point if the infections observed in this study occurred before or after employment.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Hepatitis B virus is a small enveloped partly double stranded nucleic acid (DNA) hepatotoxic virus belonging to the *hepadnaviridae* family, its genome encodes HBsAg, HBcAg, the viral polymerase and the HBx protein (Kotha et al., 2018; Trepo et al., 2014). This virus circulates in serum as a 42-nm, particle, with an outer envelope component of HBsAg and an inner nucleocapsid component of hepatitis B core antigen, HBcAg (WHO, 2015). The incubation period of HBV infection ranges between 1-6 months with approximately 70% of acute infection being asymptomatic while symptomatic hepatitis present with nonspecific symptoms like fatigue, anorexia, nausea, right upper quadrant discomfort, and jaundice(Jeng et al., 2023). Due to long incubation period of HBV and being that most of infected patients are asymptomatic, this disease can easily spread among high-risk populations like HCWs. The routes of transmission for HBV include prenatally from infected mothers to neonates, sexual transmission, blood transfusion, or dialysis/organ donation, unsafe injections, and contact. Its natural progression and disease spectrum is varied and depend on host and viral risk factors, in some people, chronic hepatitis B (CHB) is inactive and does not lead to significant liver disease while in about 15-40% of people it may be progressive liver fibrosis that presents with liver cirrhosis and hepatocellular carcinoma (HCC) (Liang, 2009). In the last 2 decades, the incidence of HCC has increased globally and is accounts for 75-85% of total liver cancer, it's now among top 5 most frequent cancer with increased annual mortality of about 300 000–500 000 persons yearly, with this high incidence more efforts should be put in place to diagnose and prevent its source more so among predisposed populations like HCWs (Lavanchy, 2004; Li et al., 2022).

Serological testing is essential for diagnosis and monitoring HBV infection, several viral antigens and their respective antibodies can be detected in serum after infection with HBV(Jeng et al., 2023). Different serologic "markers" or combinations of markers can be used to detect and identify different phases of HBV infection, determine whether a patient has acute or chronic HBV infection, is immune to HBV because of prior infection or vaccination, or is susceptible to infection (Kotha et al., 2018; Trepo et al., 2014). The presence of HBsAg, a protein on the surface of HBV that appears in blood and can be detected in high levels in serum during active acute

or chronic HBV infection. The presence of HBsAg indicates that the person is infectious, the body normally produces antibodies to HBsAg as part of the normal immune response to infection, this protein is used to make hepatitis B vaccine (Ceesay et al., 2022).

The HBsAg test is used in conjunction with other blood tests like hepatitis B surface antibody (anti-HBs) and total antibody to hepatitis B core antigen (anti-HBc) to allow the detection of the virus and the stratification of the disease phase, presence of total hepatitis B core antibody (anti-HBc) appears at the onset of symptoms in acute hepatitis B and persists for life, its presence indicates previous or ongoing infection with HBV in an undefined time frame people who have immunity to hepatitis B vaccine do not have anti HBc (European Association for the Study of the Liver. Electronic address & European Association for the Study of the, 2017). presence of anti-HBs is interpreted as indicating recovery and immunity from HBV infection, it also develops in a person who has been successfully vaccinated against hepatitis B. Among vaccine responders who completed a vaccine series, anti-HBs levels can decline over time, however the majority are still immune and will mount a response when exposed to HBV.(Kao, 2008). Serum or plasma is the specimen of choice for serological tests to detect HBV antigen or antibodies for diagnosis (Krajden et al., 2005).

2.2 Prevalence of Hepatitis B virus (HBV) infections among HCWs

The burden and HBV infections among HCWs has been documented for more than 5 decades, HCWs were recognised to be at high risk of HBV infection as an occupational hazard, in 1970 HCWs were found to be 10 times at high risk of HBV infection than the general public, the risk of transmission in HCS is mostly from patients to HCWs and less commonly from HCWs to patients (Pappas, 2021) (Service, 2001). HBV specifically present as an important occupational hazard to health care workers due to its ease of transmission and longer environmental stay for more than 7 days (Service, 2001). Chronically infected HBV curriers are able to transmit the virus to susceptible host through contact with their blood and body secretions making health care personnel to be at higher risk due to the exposure through contact with infectious waste and needle stick injury (WHO, 2017). The risk of acquiring HBV infection in HCS could occur through transmission of the virus from HCWs to patients, patients to HCWs, patients to patients or from HCWs to

HCWs if basic IPC measures are not well laid and adhered to (MOH., 2010). HBV infection among HCWs could contribute to community transmission of HBV infection (Mabunda et al., 2022). A study on HBV infection among US army HCWs found 5.0% positivity rate among officers taking care of patients with higher positivity among those who had longer work duration in surgical care centers (Segal et al., 1976). Hepatitis B virus remain a major public health problem among developing countries, in Africa, studies have documented the prevalence of HBV among HCWs and medical waste handlers in Tanzania 7.0%, Mozambique 5.1%, Uganda 8.1%, Ethiopia waste handlers 1.3% (Amsalu et al., 2016; Mabunda et al., 2022; Mueller et al., 2015; Ziraba et al., 2010). In Kenya, the metanalysis showed pooled prevalence of HBV is 7.8% putting the country one of the highest in the region(Makokha et al., 2023).

The studies have shown that with proper implementation and adherence to universal and standard precautions could reduce the transmission of HBV between HCWs to patients and vice versa(Lewis et al., 2015). Despite this high prevalence, there is no published national review on the sero-epidemiology of HBV studies, there is also paucity of data on the prevalence and corelates of HBV infection among HCWs in Kenya.

2.3 Risk factors associated with Hepatitis B virus infection among HCWs.

Health-care workers (HCWs) are at four-fold increased risk of acquiring HBV infections compared to the general public, the main risk factors to contract HBV infection for HCWs is direct contact with infectious materials in waste, especially HBV-infected blood or via a needle stick injury with HBV-contaminated body fluids, transmission of HBV in HCS may occur through percutaneous and mucocutaneous and sometimes, through exposure to other body fluids (Dannetun et al., 2006; Pruss-Ustun et al., 2005). In countries where HBV prevalence is high, most of its transmission occurs at childhood and early adulthood, a significant proportion of people who work in high risk areas like hospitals remains susceptible to HBV and is, therefore, at risk of contracting the virus during their adult age (Jha et al., 2012; Ziraba et al., 2010). Risk factors like needle stick injury, contact exposure, failure to be vaccinated, poor waste management and non-adherence to standard and additional infection prevention and control measures predisposed HCWs to blood borne pathogens like Hepatitis B infection (Shindano et al., 2017).

2.4 Needle stick injury and contact exposures among health care workers.

Healthcare workers worldwide are at risk of exposure to contaminated blood and body fluids, this accidental exposure could occur through mucocutaneus contacts (contact with nonintact skin, mucosa of the mouth or eye) or percutaneous injury (scalpel blade or sharp object cut or needlestick penetrate the skin) contaminated with bacteria, parasites, yeasts, or viruses like Hepatitis B virus (Tarantola et al., 2006). Globally there is limited data about the burden of percutaneous injury and mucosal membrane contacts among HCWs, a met analysis study found 65.7% pooled lifetime and 48.0% 12-month prevalence of occupational exposure to body fluids, exposure was largely due to percutaneous injury, which had an estimated 12-month prevalence of 36.0% (Auta et al., 2018).

In 2005, the Kenya health workers survey to determine HCWs readiness to provide HIV/AIDS services found that 16.9% of the HCWs has experienced possible exposure past 12 months, this exposures could lead to acquisition of HIV, hepatitis or other blood born pathogen infection(National AIDS and STD Control Programme, 2006). HBV can spread in health care setting through accidental or occupational exposure, Improper waste management may lead to needle stick injury thus predisposing HCW to infections (Lewis et al., 2015; Shehu et al., 2019). Studies in Africa have documented some scientists accept 5% of all HIV infections are due to unsafe injections (Zhu et al., 2019). It has been estimated that annually above three million HCWs experience percutaneous injury and contact exposure with contaminated object, these could result to over 66, 000 HBV infections that could lead to morbidity worldwide (Pruss-Ustun et al., 2005). Hepatitis B virus is also a transfusion transmissible infection (TTI). Studies from Homabay, Kisumu and Siaya shows that overall TTI (HIV, HBV, HCV, and Syphilis) prevalence of 9.4% with Hepatitis B virus has the highest prevalence and most common TTI (Roien et al., 2021; Sapkota et al., 2014). HCWs handing these samples and tests need should adhere to proper infection prevention measures to avoid occupational exposure (percutaneous injury or mucocutaneous contact) from the samples that are brought for screening before transfusion. HCWs who get exposed to HBV infections should receive Postexposure prophylaxis (PEP) with hepatitis B immune globulin (HBIG). Additionally, hepatitis B vaccine series should be considered for occupational exposures post evaluation of HBV serostatus of the source and HBV vaccination and vaccine immune status of the

exposed person (Service, 2001). However, these tests and PEP are hard to reach in low- and middle-income country like Kenya due to high cost, knowledge gap, lack of surveillance system and low infrastructural and testing capacity in low and mid-level hospitals.

2.5 HBV vaccination for Health care workers

Vaccination has been proven to be effective in prevention of HBV, susceptible household members and sexual partners with CHB are at higher risk of HBV infection and should be vaccinated ("WHO Guidelines Approved by the Guidelines Review Committee," 2015). In Kenya horizontal transmission rather than vertical transmission plays a significant role in the epidemiology of Hepatitis B viral infection. Universal infant immunization is now recognized as the ideal strategy for the early long-term control of chronic HBV infection and its sequelae like cirrhosis and liver cancer (Ministry of Health, 2013).

Since the major route of transmission of Hepatitis B in Kenya is child to child (horizontal transmission) rather than peri-natal transmission, Hepatitis B vaccination at birth has no significant advantage over Hepatitis B vaccination started at 6 weeks of age, in the reduction of HBV infections of young children. Infants are vaccinated with 3 doses of Hepatitis B vaccine in combination vaccines containing diphtheria & tetanus toxoids, and *haemophyllus influenza* type b. Monovalent Hep B vaccine is recommended for the prevention of hepatitis b in health workers and other risk groups in three scheduled doses administered at 0,4 and 6 months (Ministry of Health, 2023). Studies have shown low HBV vaccine uptake and considerable number of HCWs have not been fully vaccinated thus remain susceptible to contracting HBV infections (Amsalu et al., 2016; Reynolds et al., 2018). Even though post vaccination testing for anti-HBs is not recommended in any guideline, it should be considered for high-risk group like HCWs because evidence shows that about 10% of healthy adults do not mount an anti-HBs response to the primary immunization and non-responders should receive a repeat three-dose (1 month apart) course of vaccination to give rise to protective antibody levels ("WHO Guidelines Approved by the Guidelines Review Committee," 2015). In 2002, Kenya introduced universal hepatitis B vaccine for infants however this vaccine is not routinely available for the adult populations pointing to the low vaccine uptake (Sapkota et al., 2014). This study assessed the relationship of HBV infection and their associations of age, gender, HBV

immunization, duration of exposure, marital status, education, occupation, and trainings.

2.6 Health Care Waste Management

Health care services and related activities in hospitals restore health and save life (Reynolds et al., 2018). These activities also produce hazardous (contaminated) and non-hazardous (non-contaminated) waste which if poorly managed are potential HAI like infection with HBV (Chartier et al., 2014). Exposure to infectious waste may lead to transmission of variety of infections such as typhoid, hepatitis C Virus (HCV), hepatitis B Virus (HBV), Human Immunodeficiency Virus (HIV), Escherichia coli, staphylococcus aureus, and pseudomonas aeruginosa among others (Sapkota et al., 2014). HBV, HCV and HIV accounts for most cases of occupational exposures due to their high virulence and prevalence (Franka et al., 2009). The WHO recommends hand hygiene, injection safety, proper waste management, safe cleaning of equipment's, improved access to safe blood and training of health care workers as preventive measures to HBV infection in health care settings ("WHO Guidelines Approved by the Guidelines Review Committee," 2015).

Knowing and understanding the type, quantity and location of waste produced in a health care facility is an important first step to its safe disposal, all HCWs should be familiar with waste produced and its channel of disposal (Chartier et al., 2014). There is limited data on global knowledge of HCWs on HBV infection, risk, prevention, and waste management. In Afghanistan there is knowledge gap, low HBV vaccine uptake and poor attitude towards HBV prevention (Roien et al., 2021). In Nigeria, there is sub-optimal health care workers knowledge on hand hygiene, practice and training (Shehu et al., 2019)

2.7 Availability and Adequacy of PPE in Healthcare Settings.

In Ethiopian and India, despite availability of policies and there is poor performance pertaining to standard precautions and poor adherence to use of PPE either due to resource constrain and knowledge gap(Zhu et al., 2019). There is need to strengthen formal and on job training, provide adequate resources to improve and implement targeted infection prevention strategies. This study assessed the HCW knowledge on waste management and risk of hepatitis B transmission.

2.8 Conceptual Framework

This conceptual framework originated from the research literature based on the need to document the prevalence of HBV infection among HCWs. The framework explains the relationship between Hepatitis B virus infection and risk factors, which is the dependent variable and the independent variables like sociodemographic characteristics and risk of exposure to HBV infections. Sociodemographic characteristics like age, sex, year of service and marital status could influence HBV infectious status. HCWs who have been in service for longer years may have had more instances of accidental needle stick injury and contact exposures. Subsequently being that HBV infection could be transmitted through sexual contacts, being married could increase the risk of HBV infection among the HCWs.

Occupational risks like needle stick injury, contact exposures, lack of vaccination of HCWs, infectious waste management and disposal, availability, and adequacy of PPEs to HCWs and training of HCWs on PPEs usage, waste management and infectious agent in the waste could predispose HCWs on getting HBV infection. Poor waste segregation and disposal methods could lead to increase in contact exposures and needle stick injuries that predisposes the health care workers against acquiring infections like HBV.

HBV immunization among HCWs is one of the effective HBV prevention strategies for high-risk group like HCWs, it's been documented that there is low HBV vaccine coverage and completion rate among HCWs, this predisposes HCWs on acquiring the infection. Policies on vaccination, infection prevention and control, waste management and surveillance system for HCWs on HAI are intervening to minimize the risk of infection. However, these intervening variables require implementation and adherence to achieve its effects. This study sought to demonstrate the relationship between dependent variables of HBV infection, risk factors and the intervening variables like policies and independent variables.

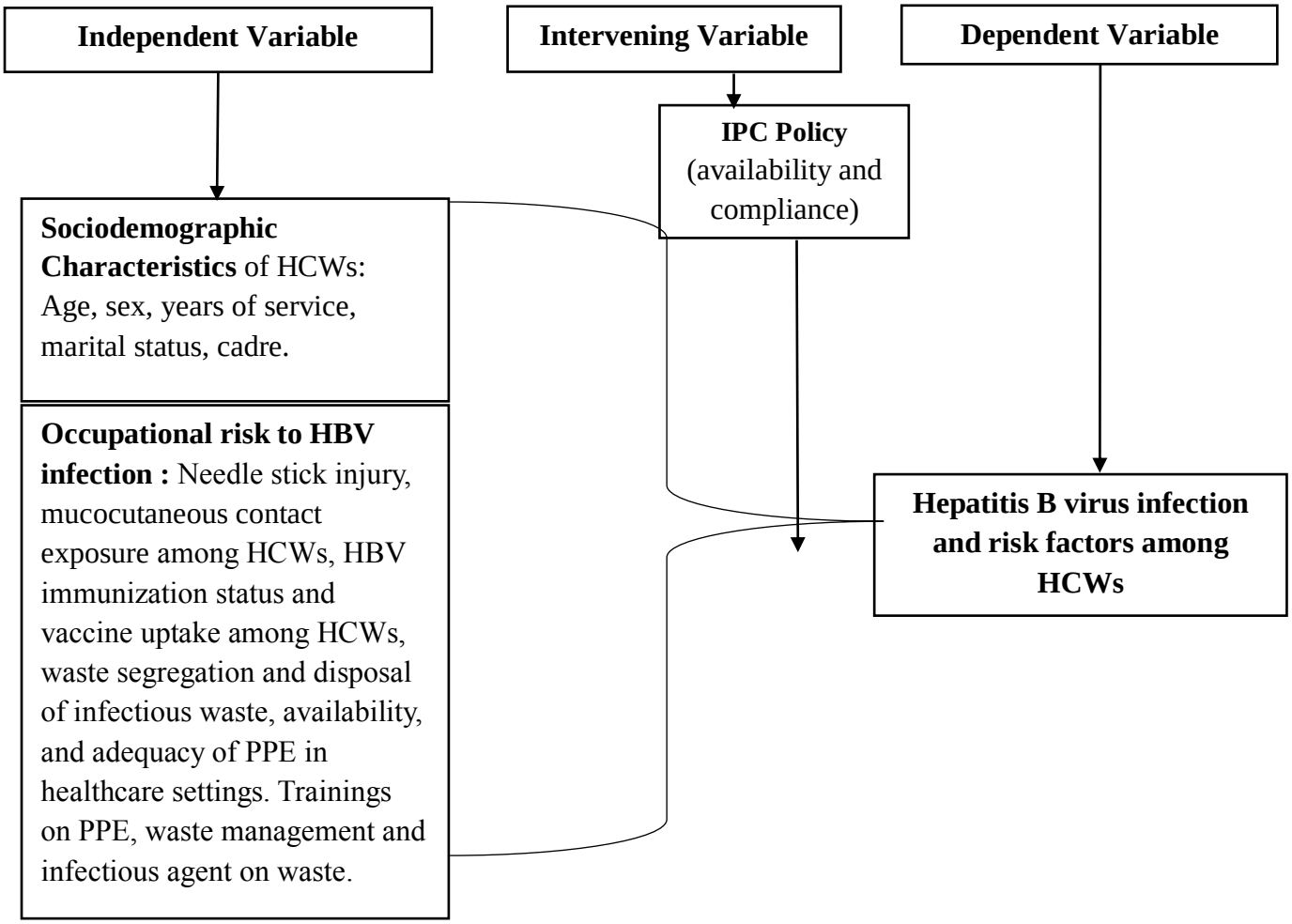


Figure 1: *Conceptual Framework*

CHAPTER THREE: METHODOLOGY

3.1 Study Design

This was a descriptive cross-sectional study conducted in one year (between May 2020 to April 2021) to determine the prevalence of Hepatitis B surface antigen (HBsAg), hepatitis B surface antibody (HBsAb) and hepatitis B core antibody (HBcAb) among HCWs in selected health facilities in Kisumu County, Kenya.

3.2 Study Sites

This study was conducted in nine high-patient volume public health facilities located in each of the 7 sub counties in Kisumu County, they provide quality primary and referral medical care services, medical education, and training for health care workers in the county and have different structural establishments depending on the levels. These hospitals generate all types of medical waste; the nature and type of medical waste being handled in each hospital vary depending on the hospital capacity and type of medical services/procedure they offer. The study hospitals comprised of sub county referral hospitals, county referral hospitals and a teaching and referral hospital as described below.

3.2.1 Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH)

This hospital is in Kisumu central sub county, Kondele Ward, it is the largest teaching and referral hospital in Kisumu County, and according to KHIS there were 285,166 patients seen in this hospital in the year 2021. It serves as a referral hospital for all the counties in Western Kenya and students from the medical universities and colleges also used it for student's practicum experience. The hospital offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinics (ear, nose, and throat (ENT), eye, TB and leprosy, sexually transmitted diseases (STI), psychiatry, orthopedic, occupational therapy, dental, physiotherapy, surgical, obstetrics/gynecology and pediatric) maternal and child health (MCH), family planning (FP) clinic and mortuary services, among others. The facility has a total 336 staff members of which 294 are clinical health care workers, 40 support staff and two mortuary staff.

3.2.2 Kisumu County Referral Hospital (KCH)

This hospital is in Kisumu Central Sub County, Market Milimani ward and is the second largest referral hospital in Kisumu County. In 2O21 the hospital served a total

of 150,891 patients and offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory, special clinic (Ear nose and throat (ENT), TB and leprosy, psychiatry, orthopedic, occupational therapy, dental, physiotherapy, surgical, obstetrics/gynecology and pediatric) maternal and child health (MCH), family planning (FP) clinic and mortuary.

The facility has a total 226 staff of which 204 are clinical health care workers, 21 are support staff and one mortuary staff.

3.2.3 Muhoroni county Hospital

This hospital is in in Muhoroni sub county, it is the largest public hospital in Muhoroni sub-County. In 2021 it served a total of 12,579 patients, it offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (TB and leprosy, orthopedic) surgical, maternal& child health (MCH), family planning (FP) clinic, mortuary. The facility has a total 35 staff, 34 clinical health care workers and one support staff.

3.2.4 Ahero County Hospital

This hospital is in located in Nyando Sub County and is the largest referral hospital in the sub-County. In 2021 it attended to 78,743 patients and offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (, TB and leprosy, physiotherapy,) maternal& child health (MCH), family planning (FP) clinic and mortuary services among others. The facility has a total 51 staff, 47 clinical health care workers, 3 support staff and 1 mortuary.

3.2.5 Gita Sub County Hospital

This hospital is in Kisumu East sub county, Kajulu ward and serves as the largest hospital in the sub-County. In 2021 it served a total of 16,977 patients. This hospital offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (TB and leprosy, physiotherapy,) maternal& child health (MCH), family planning (FP) clinic among others. The facility has 10 clinical health care staff.

3.2.6 Chulaimbo Sub County Referral Hospital

This hospital is in Kisumu west Sub County and serves as the referral hospital in the sub-County. In 2021 it attended to a total of 24,806 patients. It offers the following

medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (TB and leprosy, eye clinic, orthopedic, occupational therapy, physiotherapy and surgical) maternal& child health (MCH), family planning (FP) clinic, mortuary among others. The facility has a total 40 staff of which 35 are clinical health care staff and five are support staff.

3.2.7 Nyakach County Hospital

This hospital is in Nyakach Sub County. It serves as the referral hospital in the sub-County. In 2021 it attended to 14,342 patients, the facility offers following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory, special clinic (TB and leprosy, occupational physiotherapy,) maternal& child health (MCH), family planning (FP) clinic among others. The facility has a total of 54 staff of which 49 are clinical health care workers and five are support staff.

3.2.8 Kombewa Sub County Hospital

This hospital is in Seme Sub County and serves as the largest referral hospital. In 2018 the facility offered services to 51, 391 patients. The medical services offered in the facility are general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (TB and leprosy, orthopedic, occupational therapy, physiotherapy, pediatric) maternal& child health (MCH), family planning (FP) clinic among others. The facility has a total 84 staff of which 77 are clinical health care workers and seven are support staff.

3.2.9 Lumumba Sub County Hospital

This hospital is in Kisumu central county, Shauri Moyo Kaloleni ward where serves as Sub County hospital. In 2018 the facility offered services to 81,287 patients. It offers the following medical services: general outpatient (OPD), inpatient (IPD), maternity, pharmacy, laboratory special clinic (TB and leprosy, orthopedic, occupational therapy, physiotherapy, pediatric) maternal& child health (MCH), family planning (FP) clinic among others. The facility has a total 30 staff of which 23 are clinical health care workers and seven are support staff.

3.3 Study Population

The study targeted 192 health care workers (nurses, doctors, clinical officers, laboratory technologists, mortuary technicians, HIV testing counsellors and medical waste handlers.

3.4 Inclusion Criteria

The following inclusion criteria was used to include participants in the study:

i. The study participants should be 18 years of age and above.
ii. All medical waste handlers (Cleaning hospital, waste transporters handling waste, linen cleaners, mortuary cleaners)
iii. Health care workers (Nurses, clinical officers, Doctors, Clinical officers, Laboratory technologists)
iv. Consent to be in the study and sample collected.

3.5 Exclusion Criteria

i. Patients on treatment for Hepatitis B Virus
ii. Individuals who self-report to be known HBV positive.
iii. Staff members who are on leave or off duty at the time of the study

3.6 Sample Size Determination

There were total of 823 HCWs in the selected hospitals, being that these are high-patients volume public hospitals in Kisumu County, they had corresponding high number and carder of HCWs to match the work volume. Sample size representative of the number of HCWs offering services in the selected health facilities was estimated, Cochran formulae for estimating sample size in prevalence studies was used (Arya et al., 2012) with estimation of 14.6% prevalence, 5% precision at 95% confidence interval. The final sample size was 192 which is 23.3% (192/823) of total health care workforce in the selected facilities has been calculated using Cochran formula below:

$N=Z^2 P (1-P)/d^2$

Where N is the sample size

Z is the standard normal variate at confidence level of 95% (1.96)

P is the prevalence of HBV in health care workers 14.6%. Reference anti HBC among HCW(Wijayadi et al., 2018).

D is the level of precision (sampling error) (5%)

Therefore,

$N= Z^2 P (1-P)/d^2$

$= (1.96)^2 * 0.146(1-0.146)/ (0.05)^2$

= 191.5944215

The sample size will therefore be 192 study participants.

3.7 Sampling

Probability proportional to size (PPS) sampling was used to determine the number of health care workers to be sampled in each selected health facility and departments (clinics). Departmental duty roster was requested from facility/ departmental in charges, simple random sampling from duty roster was used to select study participants until required sample size is reached per facility and clinic.

3.8 Data Collection Procedures

After obtaining informed consent from participant, the following data was collected from the participants using structured questionnaire: (i) HCWs socio-demographic, (ii) training of HCWs on PPE usage, infectious agent on waste and waste management, (iii) HBV infection risk factors: Percutaneous injury or mucocutaneous contact exposure among HCWs, HBV vaccine uptake and immunization status among HCWs, waste segregation and disposal of infectious waste in health care settings, (iv)availability and adequacy of PPE to HCWs.

3.8.1 Pilot study (validation of the questionnaire)

To evaluate the language, comprehension, and flow of questions, stability of measures, a pilot study was done at Railways dispensary.

3.9 Laboratory Procedures

3.9.1 Samples collection transportation and storage.

Qualified and well-trained phlebotomist collected 4.0 ml of venous blood in a 4ml ethylene-diamine-tetra-acetic acid (EDTA) (Becton, Dickinson and Company, Franklin Lakes, New Jersey, USA) from the consented study participants, the sample vacutainer was labelled with participant serial number. The whole blood was triple packed and transported in a cool box within 4 hours of collection to and transported in a cool box to Kenya Medical Research Institute, Human Immunodeficiency Virus-Research (KEMRI-HIV-R) Laboratory serology section located at Clinical research Centre (CRC) next to JOOTRH for processing and testing. Whole blood in EDTA was centrifuged at 3,500 rpm for 10 minutes, plasma was harvested and stored at -20°C until testing was done.

3.9.2 Laboratory Analysis

Evaluation of HBV infection was based on three biomarkers: hepatitis B surface antigen (HBsAg), antibodies against hepatitis B surface antigen (anti-HBs), and

antibodies against total hepatitis B core antigen (anti-HBc). All tests and quality controls were performed by a qualified, trained, and competent assessed laboratory scientists according to the manufacturer's instruction and recommendation in an ISO 15189 accredited laboratory. Prior to testing plasma samples and reagents were brought to a room temperature.

3.9.3 Testing for current HBV (HBsAg) infection

This was done using Murex HBsAg version 3 kit. Substrates and wash fluids were prepared. Wells were prepared equivalent to the samples to be tested, 192 for samples and 2 for controls (positive and negative), 25µl of Sample diluent was added to each into each well, 75µL of samples or controls was added to the respective wells. To avoid possible cross-contamination during the sample addition, control specimens were dispensed into their respective wells only after all the test specimens have been dispensed, plates were covered and incubated for 1 hour at 37^{o}C +-1°C, 50µl of conjugate was added to each well and plates Shaked using a plate shaker for 10 seconds, wells were covered and incubated for 30 minutes at 37^{o}C+-1. After incubation plates were washed 5 times, inverted and excess fluid tapped out using absorbent paper, immediately after washing the plate 100µl of substrate solution was added to each well. Plates were covered with the lid and incubated for 30 minutes at 37 ^{o} C +/- 1°C while colour develops. A purple colour developed in wells containing reactive samples, 50µl stop solution (0.5M - 2M Sulphuric acid) was added to each to each well using the multichannel pipette. Absorbance was read at 450nm using 620nm to 690nm as the reference wavelength. Instruments was blanked on air with no plates inside. Manufacturer recommended software program calculated the cut offs and gave interpretation of results as Negative or positive depending on the cut-offs.

3.9.4 Testing for Immunity to HBV infection (Anti HBs)

This was done using anti-HBs using ETI-AB-AUK-3 Diasorin anti-HBs EIA kit. Briefly, microwells sufficient for all 192 samples and 2 controls (positive and negative) were prepared, calibrators, and control samples were placed in the wells. Plasma samples and controls were added to microwells coated with antigen. Excess sample was removed by washing. Enzyme conjugate (peroxidase) was added to the wells and incubated. Excess conjugate was removed by washing. Substrate was then added and incubated. A stop solution (sulfuric acid) was then added to halt the

reaction. Absorbance levels (615–630 nm) in the microwells were then measured by the instrument spectrophotometer. Results were compared with the calibrators using a test-and kit-dependent formula to ascertain whether the test result was reactive, equivocal, or nonreactive.

3.9.5 Testing for Past Exposure to HBV infection (Anti HBc)

This was done using Murex anti-HBc (total) kit. Working substrates and wash fluids were prepared. Wells were prepared equivalent to the samples to be tested, 192 for samples and 2 for controls (positive and negative), 50µl of Sample diluent was added to each into each well, 50 µL of samples or controls was added to the respective wells with controls being dispensed into their respective wells only after all the test specimens have been dispensed, plates were covered and incubated for 30 Minutes at 37^{o}C +-1°C. After incubation plates were washed, inverted and excess fluid tapped out using absorbent paper, 50µl of conjugate was added, and plates incubated at 37°C for 30 minutes. Plates were washed, inverted and excess fluid tapped out using absorbent paper, immediately after washing the plate 100µl of substrate solution was added to each well. Plates were covered with the lid and incubated away from direct light for 30 minutes at 37 ^{o}C +/- 1°C, after 30 minutes, 50µl stop solution was added and incubated for 15 minutes. Absorbance was read at 450nm using 620nm to 690nm as the reference wavelength. Instruments was blanked on air with no plates inside. Manufacturer recommended software program calculated the cut offs and gave interpretation of results as Negative or positive depending on the cut-offs.

3.10 Data Management and Analysis

Paper and electronic records with participant personally identifiable information (PID) were stored in a lockable cabinet only accessible to the study principal investigator, computer with participants data was password protected, excel data was also password protected. Data was collected in room with door and lock for visual and audio privacy. Before data analysis, data was de identified to remove all PID (client name) each client was assigned a code instead of client name. Data analysis was done on deidentified data, all data for dissemination i.e manuscript and thesis did not have PID. Data was analysed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Results were summarized using descriptive statistics. Logistic regression models were used for bivariate and presented as odd ratios (OR) with 95% confidence intervals

(CI). Multivariable analyses were performed for factors attaining p-values ≤0.2 in bivariate analysis to determine independent factors associated with HBV infection (positive for HBsAg or anti-HBc) among HCWs and presented as adjusted OR (aOR). A threshold p-value of less than 0.05 was considered statistically significant. The models were adjusted for age and gender.

3.11 Ethical Considerations

Study approval was sought from the Board of Postgraduate Studies, Jaramogi Oginga Odinga University of Science and Technology. Ethical approval was sought form Jaramogi Oginga Odinga teaching and referral Hospital (JOOTRH) Ethics Review Board, followed by a research permit from National Commission for Science Technology and Innovation (NACOSTI) Permission to conduct the study was sought from Kisumu County Director of health and medical superintendents of respective study health facilities. Participation in the study was voluntary and informed consent was obtained from the consented participants. Participants were assured that information obtained during the study were to be kept confidential. All laboratory testing was performed at no cost to the participants and were borne by the study. In addition, individuals negative for HBsAg, anti HBc and anti HBs were be offered free HBV vaccination by the County Government of Kisumu through Kenya Expanded Programme on Immunization (KEPI) while those found positive were referred to the clinicians in their respective health facility for management and further investigations and follow up. Information obtained at any course of the study are kept confidential, on-site training was given to HCWs on how to handle, transport, and dispose of medical waste and about possible infectious agent that can be encountered in medical waste handling.

CHAPTER FOUR: RESULTS

4.1 Socio-demographic characteristics of HCWs in Kisumu County

Table 4.1

Socio-demographic characteristics of the study population **(N= 192)**

Variables	Frequency (N)	Percent (%)
Sex		
Female	92	47.92
Male	100	52.08
Age (years)		
20-29	65	33.85
30-39	83	43.23
40-49	23	11.98
≥50	21	10.94
Marital status		
Single	37	19.27
Married	151	78.65
Widowed/Separated/Divorced	4	2.08
Years of service (years)		
Less than 1	8	4.17
1-5	85	44.27
6-10	51	26.56
>10	48	25
Cadre		
Doctors	8	4.17
Clinical Officer	29	15.1
Nursing officer	39	20.31
Laboratory technologist	55	28.65
Mortuary attendance	7	3.65
HIV testing counsellor	17	8.85
Medical waste handlers	37	19.27

Values are presented as numbers and proportions (%)

The median participants age was 34.4 years with interquartile range of 11 (28-39), majority of participants 43.2% had age ranging between 30 to 39 years. Most participants 52.1% were male while higher proportion 78.7% were married. On years of service, 44.3 % had 1 to 5 years of service while lower proportion 4.17% had worked for less than 1 year. Top four highest cadre who participated in this study were laboratory technologist, Nursing officer, medical waste handlers and clinical officers at 28.7%, 20.3%, 19.3% and 15.1% respectively as shown in Table 4.1

4.2 HBV Risk factors among HCWs in Kisumu County

Table 4.2

HBV Risk factors among HCWs in Kisumu County **(N= 192)**

Variables		Frequency	Percent (%)
HBV Vaccine uptake			
	3 doses	69	35.9
	2 doses	15	7.8
	1 dose	30	15.6
	Not vaccinated	78	40.6
History of exposure			
	Needle Stick Injury	91	47.4
	Contact Exposure	11	5.7
	No Known Exposure	90	46.9
Training on PPE usage			
	No	141	26.6
	Yes	51	73.4
Training on infectious agent on waste			
	No	130	67.7
	Yes	62	32.3
Training on waste management			
	No	134	69.8
	Yes	58	30.2
Availability of PPEs			
	No	18	9.4
	Yes	174	90.6
Adequacy of PPEs			
	No	149	77.6
	Yes	43	22.4
Proper waste segregation			
	No	135	70.3
	Yes	57	29.7
Waste disposal Method (Incineration)			
	No	63	32.8
	Yes	129	67.2

Values are presented as numbers and proportions (%); PPEs, personal protective equipment; HBV, Hepatitis B Virus.

Table 4.2 shows that higher proportion 53.1% of HCWs has had either contact or needle stick injury exposure at workplace, there was low HBV vaccine completion rate with only 43.8% having received ≥2 vaccine doses while 40.6% of HCWs not receiving any dose meaning they are susceptible. Majority 73.4% of HCWs had been trained on PPE usage during COVID 19 mitigation response while only 32.3% and 30.2% had been trained on infectious agent on waste and waste management respectively. Whereas 90.6% of health care workers agreed that PPEs are generally available within the work settings, 77.6% felt that they were inadequate.

There was poor waste segregation as only 29.7% of waste were segregated as per the recommended guidelines of separating the infectious waste from the general waste and having sharps in sharp boxes. Only 67.2% of the facilities were having access to incinerator either at site or through waste networking to dispose infectious waste at the facility.

4.3 Prevalence of HBV Biomarkers among HCWs in Kisumu County, 2020 (N= 192)

Table 4.3.1

Interpretation of serologic markers: Hepatitis B virus infection status and corresponding percentages among HCWs in Kisumu country, **2020 (N= 192)**

Clinical status	HBsAg	Total anti HBs	Total Anti HBc	Action taken	n (%)
Current infection	Positive	Negative	Positive	linked to hepatitis B directed care	36 (18.8)
Resolved infection (immune after infection)	Negative	Positive	Positive	offered counselling and reassurance	49 (25.5)
Immune (immunization)	Negative	Positive	Negative	offered counselling and reassurance	72 (37.5)
Susceptible (Never infected and no evidence of immunization)	Negative	Negative	Negative	vaccinated through KEPI	34 (17.7)
Isolated core antibody (Indeterminate)	Negative	Negative	Positive	Counselled and referred for further clinical advice	1(0.5)

HBsAg, hepatitis B surface antigen; Anti-HBc, hepatitis B core antibody; Anti-HBs, hepatitis B surface antibody.

Among the 192 HCWs in this study, point prevalence of HBV (current infection) was 36 (18.8%) while lifetime prevalence (developed immunity because of natural infection) was 49 (25.5%). There were 72 (37.5%) HCWs who developed immunity after vaccination while 34 (17.7%) were susceptible (never infected and had no evidence of immunization) Table 4.3.1.

Table 4.3.2

Prevalence of hepatitis B virus markers among HCWs in Kisumu County, 2020 (N= 192)

	Prevalence of HBsAg Biomarker		**Prevalence of Anti-HBs Biomarker**		**Prevalence of Anti-HBc Biomarker**	
Characteristic	N	% (95%CI)	N	% (95%CI)	N	% (95%CI)
Cadre						
Doctors	2/8	25.0 (3.19-65.1)	5/8	62.5 (24.5-91.5)	3/8	37.5 (8.5-75.5)
Clinical Officer	6/29	20.7 (8-39.7)	19/29	65.5 (45.7-82.1)	14/29	48.3 (29.5-67.5)
Nursing officer	8/39	20.5 (9.3-36.5)	25/39	64.1 (47.2-78.8)	15/39	38.5 (23.4-55.4)
Laboratory technologist	7/55	12.7 (5.3-24.5)	41/55	74.6 (61.0-85.3)	18/55	32.7 (20.7-46.7)
Mortuary attendance	0/7	0.0 (0-41.0)	4/7	57.1 (18.4-90.1)	4/7	57.1 (18.4-90.1)
HTS counsellor	5/17	29.4 (10.3-56)	6/17	35.3 (14.2-61.7)	8/17	47.1 (23.0-72.2)
Waste handlers	8/37	21.6 (9.8-38.2)	21/37	56.8 (39.5-72.9)	24/37	64.9 (47.5-79.8)
Years of service (Years)						
<1	3/8	37.5 (8.5-75.5)	4/8	50.0 (15.7-84.3)	6/8	75.0 (34.9-96.8)
1-5	13/85	15.3 (8.4-24.7)	51/85	60.0 (48.8-70.5)	31/85	36.5 (26.3-47.6)
6-10	10/51	19.6 (9.8-33.1)	38/51	74.5 (60.4-85.7)	26/51	51.0 (36.6-65.3)
>10	10/48	20.8 (10.5-35.0)	28/48	58.3 (43.2-72.4)	23/48	47.9 (33.3-62.8)
HBV Vaccine uptake						
1 dose	4/30	13.3 (3.8-30.7)	20/30	66.7 (47.2-82.7)	25/30	83.3 (65.3-94.4)
2 doses	4/15	26.7 (7.8-55.1)	8/15	53.3 (26.6-78.7)	9/15	60.0 (32.3-83.7)
3 doses	0/69	0.0 (0.0-5.2)	69/69	100.0 (94.8-100)	0/69	0.0 (0.0-5.2)
Not vaccinated	28/78	35.9 (25.3-47.6)	24/78	30.8 (20.8-42.2)	52/78	66.7 (55.1-76.9)

Values are presented as number (%); CI, confidence interval; HBsAg, hepatitis B surface antigen; Anti-HBc; hepatitis B core antibody; Anti-HCV, antibody hepatitis C virus; HBV, Hepatitis B Virus; HTS, HIV testing services.

Highest prevalence of HBsAg was in HCWs who had worked for less than one year 37.5% (95% CI: 8.5-75.5), HBV unvaccinated HCWs 35.9% (95% CI: 25.3-47.6) and HIV testing counselors 29.4% (95% CI: 10.3-56).

Anti HBc prevalence was highest among HCWs with one dose of HBV vaccine 83.3% (95% CI: 65.3-94.4), those with less than one year in service 75.0% (95% CI: 34.9-96.8) and HBV unvaccinated HCWs 66.7% (95% CI: 55.1-76.9).

There is moderate HBV immunity or recovery level among HCWs, the carders with highest anti HBs positivity were laboratory scientist 74.6% (95% CI: 61.0-85.3), clinical officers 65.5% (95% CI:45.7-82.1) and Nursing officers 64.1% (95% CI: 47.2-78.8). HTS counselors had the lowest immunity or recovery level at 35.3% (95% CI: 14.2-61.7). Prevalence of hepatitis B virus Biomarkers among HCWs is presented in Table 4.3.2.

4.4 Factors associated with Current HBV infection among HCWs in Kisumu County

Table 4.4

Factors associated with current HBV infection among HCWs in Kisumu County

Characteristic	HWC (%)	N (%)	OR (95% CI)	p-value	aOR (95% CI)	p-value
Overall	N (%)	36 (18.8)				
Cadre						
Doctors	8 (4.2)	2 (25.0)	1			
Clinical Officer	29 (15.1)	6 (20.7)	0.78 (0.12-4.90)	0.793		
Nursing officer	39 (20.3)	8 (20.5)	0.77 (0.13-4.59)	0.778		
Laboratory technologist	55 (28.7)	7 (12.7)	0.44 (0.07-2.61)	0.364		
Mortuary attendance	7 (3.7)	0 (0.0)				
HTS counsellor	17 (9.9)	5 (29.4)	1.25 (0.19-8.44)	0.819		
Waste handlers	37 (19.3)	8 (21.6)	0.83 (0.14-4.91)	0.835		
Sex						
Male	92 (47.9)	12 (12.0)	1		1	
Female	100 (52.1)	24 (26.1)	2.59 (1.21-5.54)	0.014	3.22 (1.06-9.75)	0.039
Years of service (years)						
<1	8 (4.2)	3 (37.5)	1		1	
1-5	85 (44.3)	13 (15.3)	0.30 (0.06-1.42)	0.128	0.56 (0.08-3.98)	0.56
6-10	51 (26.6)	10 (19.6)	0.41 (0.08-1.99)	0.267	1.89 (0.17-21.55)	0.607
>10	48 (25.0)	10 (20.8)	0.44 (0.09-2.15)	0.31	1.61 (0.1-25.91)	0.738
HBV Vaccine uptake						
Not vaccinated	78 (40.6)	28 (35.9)	1		1	
1 dose	30 (15.6)	4 (13.3)	0.27	0.028	0.31 (0.06-1.54)	0.153
≥2 doses	84 (43.8)	4 (4.8)	0.09	<0.0001	0.05 (0.01-0.20)	<0.0001
History of exposure						
Needle Stick Injury	91 (47.4)	8 (8.8)	1		1	
Contact Exposure	11 (5.7)	0 (0.0)	1 (-)		1 (-)	
No Known Exposure	90 (46.9)	28 (31.1)	4.69 (2.00-10.98)	<0.001	5.37 (1.81-15.92)	<0.001

Values are presented as number (%); OR, odds ratio; aOR, adjusted odds ratio; 95% CI, confidence interval; HBV, Hepatitis B Virus; HTS, HIV testing services.

Table 4.4 shows that female HCWs were more likely to have current HBV infection compared to their male counterparts (aOR, 3.22; 95% CI, 1.06-9.75, p-value< 0.05). Additionally, HCWs without a history of known exposure had increased odds of current HBV infection compared to those with a previous needle stick injury (aOR, 5.37; 95% CI, 1.81-15.92, p-value< 0.001). However, HCWs who reported receiving ≥2 doses of HBV vaccination had reduced likelihood of current HBV infection. (aOR, 0.05; 95% CI, 0.01-0.20, p-value <0.001) respectively. None of the other sociodemographic characteristics were associated with current infection of HBV among HCWs.

4.5 Factors associated with lifetime exposure to HBV infection among HCW in Kisumu County, 2020.

Table 4.5

Factors associated with lifetime exposure to HBV infection among Health care workers in Kisumu County, 2020.

Characteristics	HCW (%)	N (%)	OR (95%CI)	p-value	aOR (95% CI)	p-value
Age						
20-29	65 (33.9)	25 (38.5)	1		1	
30-39	83 (43.2)	35 (42.2)	1.17 (0.60-2.26)	0.649	1.18 (0.37-3.77)	0.784
40-49	23 (12.0)	14 (60.9)	2.49 (0.94-6.60)	0.067	1.77 (0.28-11.37)	0.547
50-59	18 (9.4)	10 (55.6)	2.00 (0.70-5.75)	0.198	3.41 (0.33-34.81)	0.301
>=60	3 (1.6)	2 (66.7)	3.2 (0.28-37.15)	0.352	0.27 (0.01-7.98)	0.452
Carder						
Doctors	8 (4.2)	3 (37.5)	1		1	
Clinical Officer	29 (15.1)	14 (48.3)	1.56 (0.31-7.75)	0.59	0.72 (0.05-10.26)	0.811
Nursing officer	39 (20.3)	15 (38.5)	1.04 (0.22-5.01)	0.959	0.49 (0.04-6.59)	0.589
Laboratory technologist	55 (28.7)	18 (32.7)	0.81 (0.17-3.78)	0.789	0.47 (0.05-4.87)	0.527
Mortuary attendance	7 (3.7)	4 (57.1)	2.22 (0.28-17.63)	0.45	0.39 (0.02-8.56)	0.578
HTS counsellor	17 (9.9)	8 (47.1)	1.48 (0.27-8.27)	0.654	0.73 (0.05-9.71)	0.811
Waste handlers	37(19.3)	24(64.9)	3.08(0.63-14.98)	0.164	2.00(0.17-22.84)	*0.578*
HBV Vaccine uptake						
Not vaccinated	78 (40.6)	52 (66.7)	1		1	
1 dose	30 (15.6)	25 (83.3)	2.5 (0.86-7.28)	0.093	6.25 (1.29-30.30)	0.023
≥2 doses	84 (43.8)	9 (10.7)	0.06 (0.03-0.14)	<0.0001	0.03 (0.01-0.10)	<0.0001
History of exposure						
Needle Stick Injury	91 (47.4)	37 (40.7)	1		1	
Contact Exposure	11 (5.7)	2 (18.2)	0.32 (0.07-1.59)	0.165	0.10 (0.01-1.40)	0.087
No Known Exposure	90 (46.9)	47(52.2)	1.59 (0.89-2.87)	0.12	3.55 (1.34-9.43)	0.011

Values are presented as number (%); OR odds ratio; aOR, adjusted odds ratio; CI, confidence interval.

In logistic regression analysis shown in table 4.5 above, HCWs who received a single dose of HBV vaccination had increased likelihood of lifetime exposure to HBV

infection compared to HCWs without history of vaccination (aOR, 6.25; 95% CI, 1.29-30.30, p-value<0.05). Conversely, HCWs who reported receiving ≥2 doses of HBV vaccination had reduced likelihood of lifetime exposure to HBV infection compared to those without HBV vaccination (aOR, 0.03; 95% CI, 0.01-0.10, p-value= <0.0001). None of the other socio-demographic characteristics were significantly associated with current infection of HBV in HCWs.

4.6 HBV Prevalence by vaccine status among HCWs in Kisumu County

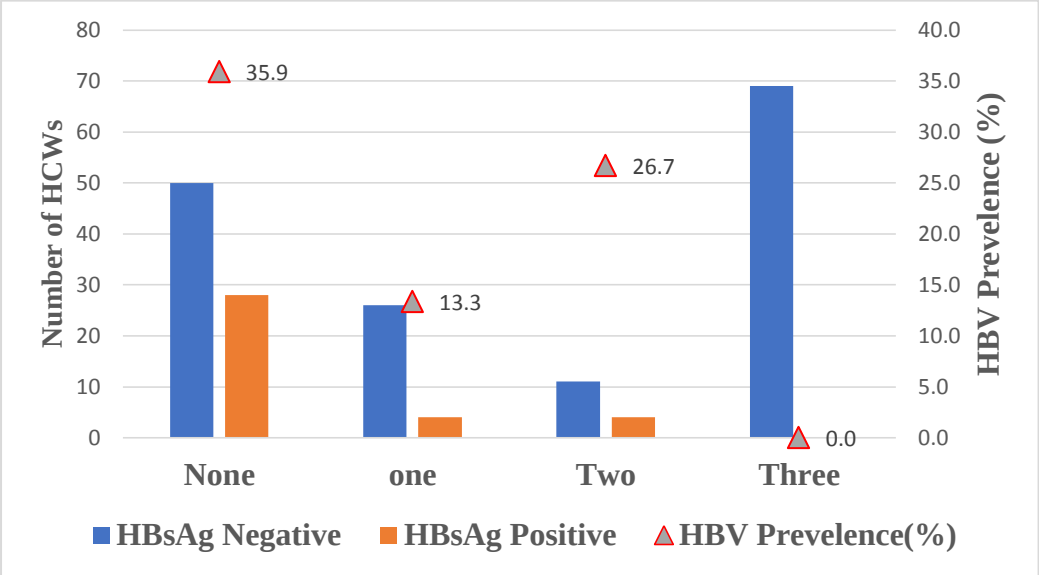


Figure 2: *HBV Prevalence by vaccine status among HCWs in Kisumu County*

Figure 2 above shows that HBV prevalence was highest 35.9% among healthcare workers who had not received any dose of HBV vaccine, those who had received one dose of vaccine had 13.3% infection rates and those who received two doses of HBV vaccine had HBV prevalence of 26.7%. Notably, none of the 69 HCWs who reported receiving all the three required doses of HBV vaccination had HBV infection.

CHAPTER FIVE: DISCUSSION

Indeed the burden of HAI like Hepatitis B infection is high in developing sub-Saharan African countries like Kenya (Allegranzi et al., 2011).This study revealed high prevalence of HBV infection among the HCWs in Kisumu County, Kenya. The overall prevalence of current HBV infection (HBsAg positivity) was 18.8 %, and exposure to HBV infection (anti-HBc positivity) was 25.5%. HBV infection was high among HCWs who had worked for less than 1 year at 37.5%, HBV unvaccinated HCWs at 35.9%, HIV testing counselors at 29.4% and HCWs who received 2 doses of vaccine at 26.7%. This high HBV prevalence confirms that despite the availability of guidelines and treatment options, occupational risks related to hepatitis virus exposure is still a major concern for those who work in the hospital and handle hospital waste (Shiferaw et al., 2011). Though Kenya has made strides in the fight against hepatitis, with adoption of national guidelines on hepatitis and treatment being made available, more still need to be done to have access to diagnosis and primary healthcare to those chronically infected with hepatitis. The prevalence of HBV infection among HCWs in this study is higher compared to 2.7% prevalence in general population (Ly et al., 2016). Other studies on HBV infection rates in Kenya and Africa among HCWs also found lower prevalence: pooled prevalence in Africa 6.8%, Kenya 4.0 %, southern Ethiopia 1.3%, north west Ethiopia 6.0 %, Tripoli Libya 2.3% and 6.3% in Addis Ababa, (Amsalu et al., 2016; Anagaw et al., 2012; Atlaw et al., 2021; Franka et al., 2009; Kisangau et al., 2019; Shiferaw et al., 2011). A study in Kisumu, Siaya and Homabay county found that the prevalence of HBV among adolescent was 3.4% while dual infection of HBV and HIV among patients presenting with jaundice in Kisumu county hospital clinic, one of our study site was 47% (Awili et al., 2020; Otedo, 2004). Most of the hepatitis B studies are not targeting HCWs, there are few studies that highlight the burden of hepatitis in this most at risk population, HCWs if infected may spread the infections to their colleagues, families and patients leading to unsafe health care (Allegranzi et al., 2011).

The high prevalence in this study could be attributed to increased HBV risk of exposure on HCWs, this study also highlighted that 47.4% and 5.7% of HCWs has had either needle stick injury or contact exposure, inadequate trainings on waste management and infectious agent found in waste, poor infection prevention infrastructure, low Hepatitis B virus vaccine coverage and low-adherence to proper

waste segregation and disposal of infectious waste as shown in table 4.2. Exposure to infected waste at health care setting is a predisposing factor to many infections including HBV, the high positivity and exposure to HBV infection coupled with inadequate infection prevention and controls measures highlighted in this study provides further evidence that HCWs have a high risk of becoming infected with HBV through their occupation(Mueller et al., 2015; Ziraba et al., 2010).

This study found low training coverage on waste management, infectious agent on waste and inadequacy of PPE at 30.2%,32.2%, 22.4% respectively. These could be the cause to high needle stick injury, contact exposure and poor adherence to standard precautions. If personal are not well trained and they lack relevant PPEs that help protect them, there is increased risk of exposure to infection at work setting (Auta et al., 2017). In response to the high positivity and risk of exposure against HBV infection, The Ministry of Health Kenya has put in place the safeguards to lessen the risk of injury. These include provision of policies and guidelines, adoption of universal and precautions, use of puncture resistant, leak proof, and labelled or color-coded waste containers and bin liners. In addition, devices have been developed to reduce injuries including retractable needles and syringes with a sliding sheath (Ministry of Health, 2023).

To reduce the exposures in the health care settings, health care system administrators should fully adopt infection prevention and control guidelines, ensure availability, accessibility, and adequacy of necessary PPEs to HCWs. Consequently, IPC trainings should be done to all health care workers with provision of annual refreshers to fully address the findings on inadequate HCWs capacity building, poor adherence on IPC standard and additional precautions to reduce HAI risk in hospitals (Kisangau et al., 2019; Sapkota et al., 2014; Zhu et al., 2019).

This study found the prevalence of HBsAb among HCWs was 37.5%, these participants were successfully immunized (recovered from infection or successfully vaccinated) while 17.7% are susceptible (never infected and no evidence of immunization). The carders with high immunization rates were laboratory technologists 74.6%, clinical officers 65.5%, and Nursing officers 64.1%. Laboratory technologists were the highest immunized carder, this concurs with a study in Mozambique where 77% of laboratory technicians were vaccinated (Mabunda et al.,

2022), the high vaccination rate in this carder may be attributed to the implementation of laboratory quality management system and international organization for standardization ISO 15189 which required that all laboratory personnel to be vaccinated against blood borne pathogens (Aoyagi, 2004). Kenya introduced universal hepatitis B vaccine for infants and administered birth dose immunization since 2002, However, nationwide hepatitis B vaccination program for high-risk groups including HCWs has not been in place(Ministry of Health, 2023). In hepatitis B endemic countries where people have high rates of natural immunity, providing universal HBV vaccination for HCWs is often discussed because of questionable cost effectiveness of this preventive measure(Pellissier et al., 2012).

The low HBV immunity rate and non-completion of vaccine doses is has been documented before and could be attributed to poor knowledge among health care workers on the risk of infectious agent on waste that warrant the need for HCWs protection through vaccination and availability and accessibility of HBV vaccine to HCWs, though this study did not collect data on vaccine availability future studies should collect this information to see if it contributed to low vaccine coverage and completion rates (Amsalu et al., 2016; Harun et al., 2022; Kisangau et al., 2019). The benefit of vaccination as HBV infection prevention measure has been documented (Mast et al., 2005), this study also found HCWs who are fully vaccinated had 0% of infection while higher rates of HBV infection was in unvaccinated HCWs at 35.9%. Findings in this study confirmed the benefits of vaccination HCWs could greatly reduce the infection rates and highlights the need to capacity build HCWs on the benefits of completing the dosage and need to avail the vaccine for all health care workforce. Significant risk of lifetime exposure to HBV infection was noted among HCWs with one vaccine dose, those with no known exposure while significant HBV protection was seen in HCWs who had adequate PPE. A study in Southern Ethiopia found HBV lifetime exposure was higher in medical waste handlers older than 40 years (Amsalu et al., 2016) while population based Azar cohort study found that all age groups were exposed to HBV. In Eastern Ethiopia, there was higher prevalence of HBV infection in trainees (Pouri et al., 2020; Tesfa et al., 2021). There is need to have remedial measures that is aimed at reducing this high lifetime exposure rates by capacity building HCWs, availing proper infrastructure for infection prevention and control, strengthening HBV vaccination and proper surveillance for HAI in all

healthcare settings. Policy should be revised to enforce mandatory HAI pre-employment screening and vaccination for personnel working in healthcare settings.

All the study participants got their results, the 36 participants positive to HBV infections were referred to health facilities of their choice for clinical review and further management, the 49 participants who had resolved infections and 72 who were fully immunized were counseled and reassured while the 34 participants who were susceptible got their vaccination through KEPI. There was one participant who had isolated core antibody, this could have resulted from: (i) false anti-HBc positive test, (ii) past HBV infection, (iii) occult HBV infection (Wu et al., 2017). There was need to know if the participant with isolated core antibody had ever become immunosuppressed or had chemotherapy, this participant was referred to clinicians for further clinical management Table 4.3.1.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Prevalence of HBsAg and anti HBc among HCWs in this study was about 6 and 5-fold higher than general population, the prevalence was higher among HCWs who had worked for less than one year, HBV unvaccinated HCWs and HIV testing counselors. This provides further evidence that HCWs have a high risk of becoming infected with HBV, the high HBV positivity and exposure may be due to high needle stick injury, contact exposure and low HBV vaccine coverage and completion rates among HCWs.

There was suboptimal training of HCWs on waste management, infectious agent on waste and PPE usage coupled with PPE inadequacy that may have led the high needle stick injury, contact exposure and poor waste management observed in this study.

This study found low HBV vaccine coverage and vaccine dose completion among HCWs. subsequently, there was high HBV infection rate among HCWs who had neither been vaccinated nor completed hepatitis B vaccine dosage. Significant relationship was also observed between immunization status and positivity for HBV. This confirms the benefit of HBV vaccination by showing that fully vaccinated HCWs have low risk of HBV infection.

6.2 Recommendations

6.1.1 Practice and policy

There should be increased surveillance on HAI like HBV infections to identify HBV infected HCWs and refer them for clinical management.

Ministry of Health (MOH) should sensitize health care workers on HBV vaccination to improve HBV vaccine uptake.

Adequate PPEs should be provided to HCWs; training should be done to HCWs on PPEs usage, waste management and infectious agent on waste to reduce occupational exposure to HBV infection.

6.1.2 Further studies

Additional studies are required to determine effect of HBV vaccine availability on vaccine coverage and uptake; causes, effects, and prevalence of isolated anti-HBc among healthcare workers; clustering pattern of HBV infections among HCWs.

REFERENCES

Adeyemi, O. A., Mitchell, A., Shutt, A., Crowell, T. A., Ndembi, N., Kokogho, A., Ramadhani, H. O., Robb, M. L., Baral, S. D., Ake, J. A., Charurat, M. E., Peel, S., Nowak, R. G., & group, T. R. s. (2021). Hepatitis B virus infection among men who have sex with men and transgender women living with or at risk for HIV: a cross sectional study in Abuja and Lagos, Nigeria. *BMC Infect Dis*, *21*(1), 654. https://doi.org/10.1186/s12879-021-06368-1

Alege, J. B., Gulom, G., Ochom, A., & Kaku, V. E. (2020). Assessing Level of Knowledge and Uptake of Hepatitis B Vaccination among Health Care Workers at Juba Teaching Hospital, Juba City, South Sudan. *Adv Prev Med*, *2020*, 8888409. https://doi.org/10.1155/2020/8888409

Allegranzi, B., Bagheri Nejad, S., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2011). Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*, *377*(9761), 228-241. https://doi.org/10.1016/S0140-6736(10)61458-4

Amsalu, A., Worku, M., Tadesse, E., & Shimelis, T. (2016). The exposure rate to hepatitis B and C viruses among medical waste handlers in three government hospitals, southern Ethiopia. *Epidemiol Health*, *38*, e2016001. https://doi.org/10.4178/epih/e2016001

Anagaw, B., Shiferaw, Y., Anagaw, B., Belyhun, Y., Erku, W., Biadgelegn, F., Moges, B., Alemu, A., Moges, F., & Mulu, A. (2012). Seroprevalence of hepatitis B and C viruses among medical waste handlers at Gondar town Health institutions, Northwest Ethiopia. *BMC Res Notes*, *5*, 55. https://doi.org/10.1186/1756-0500-5-55

Aoyagi, T. (2004). [ISO 15189 medical laboratory accreditation]. *Rinsho Byori*, *52*(10), 860-865. https://www.ncbi.nlm.nih.gov/pubmed/15624503

Arya, R., Antonisamy, B., & Kumar, S. (2012). Sample Size Estimation in Prevalence Studies. *The Indian Journal of Pediatrics*, *79*(11), 1482-1488. https://doi.org/10.1007/s12098-012-0763-3

Atlaw, D., Sahiledengle, B., & Tariku, Z. (2021). Hepatitis B and C virus infection among healthcare workers in Africa: a systematic review and meta-analysis. *Environ Health Prev Med*, *26*(1), 61. https://doi.org/10.1186/s12199-021-00983-9

Auta, A., Adewuyi, E. O., Kureh, G. T., Onoviran, N., & Adeloye, D. (2018). Hepatitis B vaccination coverage among health-care workers in Africa: A systematic review and meta-analysis. *Vaccine*, *36*(32 Pt B), 4851-4860. https://doi.org/10.1016/j.vaccine.2018.06.043

Auta, A., Adewuyi, E. O., Tor-Anyiin, A., Aziz, D., Ogbole, E., Ogbonna, B. O., & Adeloye, D. (2017). Health-care workers' occupational exposures to body fluids in 21 countries in Africa: systematic review and meta-analysis. *Bull World Health Organ*, *95*(12), 831-841F. https://doi.org/10.2471/BLT.17.195735

Awili, H. O., Gitao, G. C., & Muchemi, G. M. (2020). Seroprevalence and Risk Factors for Hepatitis B Virus Infection in Adolescent Blood Donors within Selected Counties of Western Kenya. *Biomed Res Int*, *2020*, 8578172. https://doi.org/10.1155/2020/8578172

Ceesay, A., Bouherrou, K., Tan, B. K., Lemoine, M., Ndow, G., Testoni, B., & Chemin, I. (2022). Viral Diagnosis of Hepatitis B and Delta: What We Know and What Is Still Required? Specific Focus on Low- and Middle-Income Countries. *Microorganisms*, *10*(11). https://doi.org/10.3390/microorganisms10112096

Chartier, Y., Emmanuel, J., Pieper, U., Prüss, A., Rushbrook, P., Stringer, R., Townend, W., Wilburn, S., & Zghondi, R. (2014). WHO Library Cataloguing-in-Publication Data_Safe management of wastes from health_care activities _edited by Y. Chartier et al. _2nd ed..pdf.

Dannetun, E., Tegnell, A., Torner, A., & Giesecke, J. (2006). Coverage of hepatitis B vaccination in Swedish healthcare workers. *J Hosp Infect*, *63*(2), 201-204. https://doi.org/10.1016/j.jhin.2006.01.014

Downs, L. O., Campbell, C., Yonga, P., Githinji, G., Ansari, M. A., Matthews, P. C., & Etyang, A. O. (2023). A systematic review of Hepatitis B virus (HBV) prevalence and genotypes in Kenya: Data to inform clinical care and health policy. *PLOS Glob Public Health*, *3*(1), e0001165. https://doi.org/10.1371/journal.pgph.0001165

European Association for the Study of the Liver. Electronic address, e. e. e., & European Association for the Study of the, L. (2017). EASL 2017 Clinical Practice Guidelines on the management of hepatitis B virus infection. *J Hepatol*, *67*(2), 370-398. https://doi.org/10.1016/j.jhep.2017.03.021

Franka, E., El-Zoka, A. H., Hussein, A. H., Elbakosh, M. M., Arafa, A. K., & Ghenghesh, K. S. (2009). Hepatitis B virus and hepatitis C virus in medical waste handlers in Tripoli, Libya. *J Hosp Infect*, *72*(3), 258-261. https://doi.org/10.1016/j.jhin.2009.03.019

Harun, M. G. D., Sumon, S. A., Mohona, T. M., Rahman, A., Abdullah, S., Islam, M. S., & Anwar, M. M. U. (2022). Hepatitis B Vaccination Coverage among Bangladeshi Healthcare Workers: Findings from Tertiary Care Hospitals. *Vaccines (Basel)*, *11*(1). https://doi.org/10.3390/vaccines11010041

Hostiuc, S., Molnar, A. J., Moldoveanu, A., Aluas, M., Moldoveanu, F., Bocicor, I., Dascalu, M. I., Badila, E., Hostiuc, M., & Negoi, I. (2018). Patient autonomy and disclosure of material information about hospital-acquired infections. *Infect Drug Resist*, *11*, 369-375. https://doi.org/10.2147/IDR.S149590

Jeng, W. J., Papatheodoridis, G. V., & Lok, A. S. F. (2023). Hepatitis B. *Lancet*, *401*(10381), 1039-1052. https://doi.org/10.1016/S0140-6736(22)01468-4

Jha, A. K., Chadha, S., Bhalla, P., & Saini, S. (2012). Hepatitis B infection in microbiology laboratory workers: prevalence, vaccination, and immunity status. *Hepat Res Treat*, *2012*, 520362. https://doi.org/10.1155/2012/520362

Kao, J. H. (2008). Diagnosis of hepatitis B virus infection through serological and virological markers. *Expert Rev Gastroenterol Hepatol*, *2*(4), 553-562. https://doi.org/10.1586/17474124.2.4.553

Kisangau, E. N., Awour, A., Juma, B., Odhiambo, D., Muasya, T., Kiio, S. N., Too, R., & Lowther, S. A. (2019). Prevalence of hepatitis B virus infection and uptake of hepatitis B vaccine among healthcare workers, Makueni County, Kenya 2017. *J Public Health (Oxf)*, *41*(4), 765-771. https://doi.org/10.1093/pubmed/fdy186

Kotha, S., Neong, S., & Patel, K. (2018). Serum biomarkers for diagnosis and monitoring viral hepatitis and hepatocellular carcinoma. *Expert Rev Mol Diagn*, *18*(8), 713-722. https://doi.org/10.1080/14737159.2018.1496020

Krajden, M., McNabb, G., & Petric, M. (2005). The laboratory diagnosis of hepatitis B virus. *Can J Infect Dis Med Microbiol*, *16*(2), 65-72. https://doi.org/10.1155/2005/450574

Lavanchy, D. (2004). Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures. *J Viral Hepat*, *11*(2), 97-107. https://doi.org/10.1046/j.1365-2893.2003.00487.x

Lewis, J. D., Enfield, K. B., & Sifri, C. D. (2015). Hepatitis B in healthcare workers: Transmission events and guidance for management. *World J Hepatol*, *7*(3), 488-497. https://doi.org/10.4254/wjh.v7.i3.488

Li, Q., Cao, M., Lei, L., Yang, F., Li, H., Yan, X., He, S., Zhang, S., Teng, Y., Xia, C., & Chen, W. (2022). Burden of liver cancer: From epidemiology to prevention. *Chin J Cancer Res*, *34*(6), 554-566. https://doi.org/10.21147/j.issn.1000-9604.2022.06.02

Liang, T. J. (2009). Hepatitis B: the virus and disease. *Hepatology*, *49*(5 Suppl), S13-21. https://doi.org/10.1002/hep.22881

Ly, K. N., Kim, A. A., Umuro, M., Drobenuic, J., Williamson, J. M., Montgomery, J. M., Fields, B. S., & Teshale, E. H. (2016). Prevalence of Hepatitis B Virus Infection in Kenya, 2007. *Am J Trop Med Hyg*, *95*(2), 348-353. https://doi.org/10.4269/ajtmh.16-0059

Mabunda, N., Vieira, L., Chelene, I., Maueia, C., Zicai, A. F., Duaja, A., Chale, F., Chambal, L., Vubil, A., & Augusto, O. (2022). Prevalence of hepatitis B virus and immunity status among healthcare workers in Beira City, Mozambique. *PLoS One*, *17*(10), e0276283. https://doi.org/10.1371/journal.pone.0276283

Makokha, G. N., Zhang, P., Hayes, C. N., Songok, E., & Chayama, K. (2023). The burden of Hepatitis B virus infection in Kenya: A systematic review and meta-analysis. *Front Public Health*, *11*, 986020. https://doi.org/10.3389/fpubh.2023.986020

Mast, E. E., Margolis, H. S., Fiore, A. E., Brink, E. W., Goldstein, S. T., Wang, S. A., Moyer, L. A., Bell, B. P., Alter, M. J., & Advisory Committee on Immunization, P. (2005). A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP) part 1: immunization of infants, children, and adolescents. *MMWR Recomm Rep*, *54*(RR-16), 1-31. https://www.ncbi.nlm.nih.gov/pubmed/16371945

Mbaisi, E. M., Ng'ang'a, Z., Wanzala, P., & Omolo, J. (2013). Prevalence and factors associated with percutaneous injuries and splash exposures among health-care workers in a provincial hospital, Kenya, 2010. *Pan Afr Med J*, *14*, 10. https://doi.org/10.11604/pamj.2013.14.10.1373

Ministry of Health, N. V. a. i. P. (2013). Ministry of Health, National Policy Guidlines on Immunization 2013. Nairobi,Kenya.pdf.

Ministry of Health, N. V. A. I. P. (2023). Kenya National Immunization Policy Guidelines, 2023 Edition.

Ministry of Public Health and Sanitation and Ministry of Medical Services, R. o. K. (December 2010). *National Infection Prevention and Control Guidelines for Health Care Services in Kenya*. Nairobi, Kenya.

MOH. (2010). <Ministry of Public Health and Sanitation and Ministry of Medical Services, Republic of Kenya. National Infection Prevention and Control Guidelines for Health Care Services in Kenya.>.

Mueller, A., Stoetter, L., Kalluvya, S., Stich, A., Majinge, C., Weissbrich, B., & Kasang, C. (2015). Prevalence of hepatitis B virus infection among health care workers in a tertiary hospital in Tanzania. *BMC Infect Dis*, *15*, 386. https://doi.org/10.1186/s12879-015-1129-z

Mwangi, I. A., Wesongah, J. O., Musyoki, V. M., Omosa-Manyonyi, G. S., Farah, B., Edalia, L. G., & Mbuchi, M. (2023). Assessment of hepatitis B vaccination status and hepatitis B surface antibody titres among health care workers in selected public health hospitals in Kenya. *PLOS Glob Public Health*, *3*(4), e0001741. https://doi.org/10.1371/journal.pgph.0001741

National AIDS and STD Control Programme, M. o. H., Kenya. (2006). Preparedness for HIV/AIDS service delivery: the 2005 Kenya health workers survey. Nairobi: . *Kenya Ministry of Health*. http://pdf.usaid.gov/pdf_docs/Pnadk460.pdf

Ongete, G., & Duffy, F. J. R. (2018). The impact of occupational splash, sharps and needlestick injuries (SSNIs) on the quality of life of healthcare workers in a Kenyan university hospital. *Work*, *59*(1), 103-119. https://doi.org/10.3233/WOR-172664

Otedo, A. E. (2004). HBV, HIV co-infection at Kisumu District Hospital, Kenya. *East Afr Med J*, *81*(12), 626-630. https://doi.org/10.4314/eamj.v81i12.9247

Pappas, S. C. (2021). Hepatitis B and Health Care Workers. *Clin Liver Dis*, *25*(4), 859-874. https://doi.org/10.1016/j.cld.2021.06.010

Pellissier, G., Yazdanpanah, Y., Adehossi, E., Tosini, W., Madougou, B., Ibrahima, K., Lolom, I., Legac, S., Rouveix, E., Champenois, K., Rabaud, C., & Bouvet, E. (2012). Is universal HBV vaccination of healthcare workers a relevant strategy in developing endemic countries? The case of a university hospital in Niger. *PLoS One*, *7*(9), e44442. https://doi.org/10.1371/journal.pone.0044442

Pouri, A. A., Ghojazadeh, M., Shirmohammadi, M., Eftekhar-Sadat, A. T., & Somi, M. H. (2020). Seroepidemiology and Risk Factors of Hepatitis B Virus Infection: A Population-Based Azar Cohort Study. *Iran J Public Health*, *49*(11), 2152-2160. https://doi.org/10.18502/ijph.v49i11.4733

Pruss-Ustun, A., Rapiti, E., & Hutin, Y. (2005). Estimation of the global burden of disease attributable to contaminated sharps injuries among health-care workers. *Am J Ind Med*, *48*(6), 482-490. https://doi.org/10.1002/ajim.20230

Reynolds, K., Thomas, M., & Dougan, M. (2018). Diagnosis and Management of Hepatitis in Patients on Checkpoint Blockade. *Oncologist*, *23*(9), 991-997. https://doi.org/10.1634/theoncologist.2018-0174

Roien, R., Mousavi, S. H., Ozaki, A., Baqeri, S. A., Hosseini, S. M. R., Ahmad, S., & Shrestha, S. (2021). Assessment of Knowledge, Attitude, and Practice of Health-Care Workers Towards Hepatitis B Virus Prevention in Kabul, Afghanistan. *J Multidiscip Healthc*, *14*, 3177-3186. https://doi.org/10.2147/JMDH.S334438

Sapkota, B., Gupta, G. K., & Mainali, D. (2014). Impact of intervention on healthcare waste management practices in a tertiary care governmental hospital of Nepal. *BMC Public Health*, *14*, 1005. https://doi.org/10.1186/1471-2458-14-1005

Segal, H. E., Llewellyn, C. H., Irwin, G., Bancroft, W. H., Boe, G. P., & Balaban, D. J. (1976). Hepatitis B antigen and antibody in the U.S. Army: prevalence in health care personnel. *Am J Public Health*, *66*(7), 667-671. https://doi.org/10.2105/ajph.66.7.667

Service, U. S. P. H. (2001). Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis. *MMWR Recomm Rep*, *50*(RR-11), 1-52. https://www.ncbi.nlm.nih.gov/pubmed/11442229

Shehu, N. Y., Onyedibe, K. I., Igbanugo, J. S., Okolo, M. O., Gomerep, S. S., Isa, S. E., & Egah, D. Z. (2019). Hand hygiene knowledge, training and practice: A cross-sectional study in a tertiary health institution, North-central Nigeria. *Niger J Clin Pract*, *22*(7), 1008-1013. https://doi.org/10.4103/njcp.njcp_204_18

Shiferaw, Y., Abebe, T., & Mihret, A. (2011). Hepatitis B virus infection among medical aste handlers in Addis Ababa, Ethiopia. *BMC Res Notes*, *4*, 479. https://doi.org/10.1186/1756-0500-4-479

Shindano, T. A., Bahizire, E., Fiasse, R., & Horsmans, Y. (2017). Knowledge, Attitudes, and Practices of Health-Care Workers About Viral Hepatitis B and C in South Kivu. *Am J Trop Med Hyg*, *96*(2), 400-404. https://doi.org/10.4269/ajtmh.16-0287

Tarantola, A., Abiteboul, D., & Rachline, A. (2006). Infection risks following accidental exposure to blood or body fluids in health care workers: a review of pathogens transmitted in published cases. *Am J Infect Control*, *34*(6), 367-375. https://doi.org/10.1016/j.ajic.2004.11.011

Terrault, N. A., Lok, A. S. F., McMahon, B. J., Chang, K. M., Hwang, J. P., Jonas, M. M., Brown, R. S., Jr., Bzowej, N. H., & Wong, J. B. (2018). Update on Prevention, Diagnosis, and Treatment of Chronic Hepatitis B: AASLD 2018 Hepatitis B Guidance. *Clin Liver Dis (Hoboken)*, *12*(1), 33-34. https://doi.org/10.1002/cld.728

Tesfa, T., Hawulte, B., Tolera, A., & Abate, D. (2021). Hepatitis B virus infection and associated risk factors among medical students in eastern Ethiopia. *PLoS One*, *16*(2), e0247267. https://doi.org/10.1371/journal.pone.0247267

Trepo, C., Chan, H. L., & Lok, A. (2014). Hepatitis B virus infection. *Lancet*, *384*(9959), 2053-2063. https://doi.org/10.1016/S0140-6736(14)60220-8

Tunnage, J., Yates, A., Nwoga, C., Sing'oei, V., Owuoth, J., Polyak, C. S., Crowell, T. A., & Group, R. V. S. (2021). Hepatitis and tuberculosis testing are much less common than HIV testing among adults in Kisumu, Kenya: results from a cross-sectional assessment. *BMC Public Health*, *21*(1), 1143. https://doi.org/10.1186/s12889-021-11164-2

W.H.O. (2019). *Progress report on HIV, viral hepatitis and sexually transmitted infections. Accountability for the global health sector strategies, 2016–2021*.

WHO. (2015). Guidelines for the prevention, care and treatment of persons with chronic hepatitis B infection.pdf.

WHO. (2016). Global Health sector strategy on Viral Hepatitis 2016-2021: Towards Ending Viral Hepatitis.

WHO. (2017). Global Hepatitis Report 2017_Geneva_World Health Organization_2017..pdf.

WHO Guidelines Approved by the Guidelines Review Committee. (2015). In *Guidelines for the Prevention, Care and Treatment of Persons with Chronic Hepatitis B Infection*. World Health Organization

Copyright © World Health Organization 2015.

Wijayadi, T., Sjahril, R., Turyadi, Ie, S. I., Wahyuni, R., Pattelongi, I., Massi, M. N., Yusuf, I., & Muljono, D. H. (2018). Seroepidemiology of HBV infection among health-care workers in South Sulawesi, Indonesia. *BMC Infect Dis*, *18*(1), 279. https://doi.org/10.1186/s12879-018-3190-x

Wu, T., Kwok, R. M., & Tran, T. T. (2017). Isolated anti-HBc: The Relevance of Hepatitis B Core Antibody-A Review of New Issues. *Am J Gastroenterol*, *112*(12), 1780-1788. https://doi.org/10.1038/ajg.2017.397

Zhu, S., Kahsay, K. M., & Gui, L. (2019). Knowledge, Attitudes and Practices related to standard precautions among nurses: A comparative study. *J Clin Nurs*, *28*(19-20), 3538-3546. https://doi.org/10.1111/jocn.14945

Ziraba, A. K., Bwogi, J., Namale, A., Wainaina, C. W., & Mayanja-Kizza, H. (2010). Sero-prevalence and risk factors for hepatitis B virus infection among health care workers in a tertiary hospital in Uganda. *BMC Infect Dis*, *10*, 191. https://doi.org/10.1186/1471-2334-10-191

APPENDICES

Appendix 1: Authority from Jaramogi Oginga Odinga University of science and technology.

JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE & TECHNOLOGY

BOARD OF POSTGRADUATE STUDIES

Office of the Director

Tel. 057-2501804
Email: bps@jooust.ac.ke

P.O. BOX 210 - 40601
BONDO

Our Ref: H153/4268/2015

Date: 21st May 2020

TO WHOM IT MAY CONCERN

RE: FRANKLINE OTIENO MBOYA – H153/4268/2015

The above person is a bona fide postgraduate student of Jaramogi Oginga Odinga University of Science and Technology in the School of Health Sciences pursuing Master of Science in Biomedical Science. He has been authorized by the University to undertake research on the topic: ***"Hepatitis B Virus Infection Status and Associated Risk Factors among Health Care Workers and Medical Waste Handlers in Selected Health Facilities in Kisumu County, Kenya".***

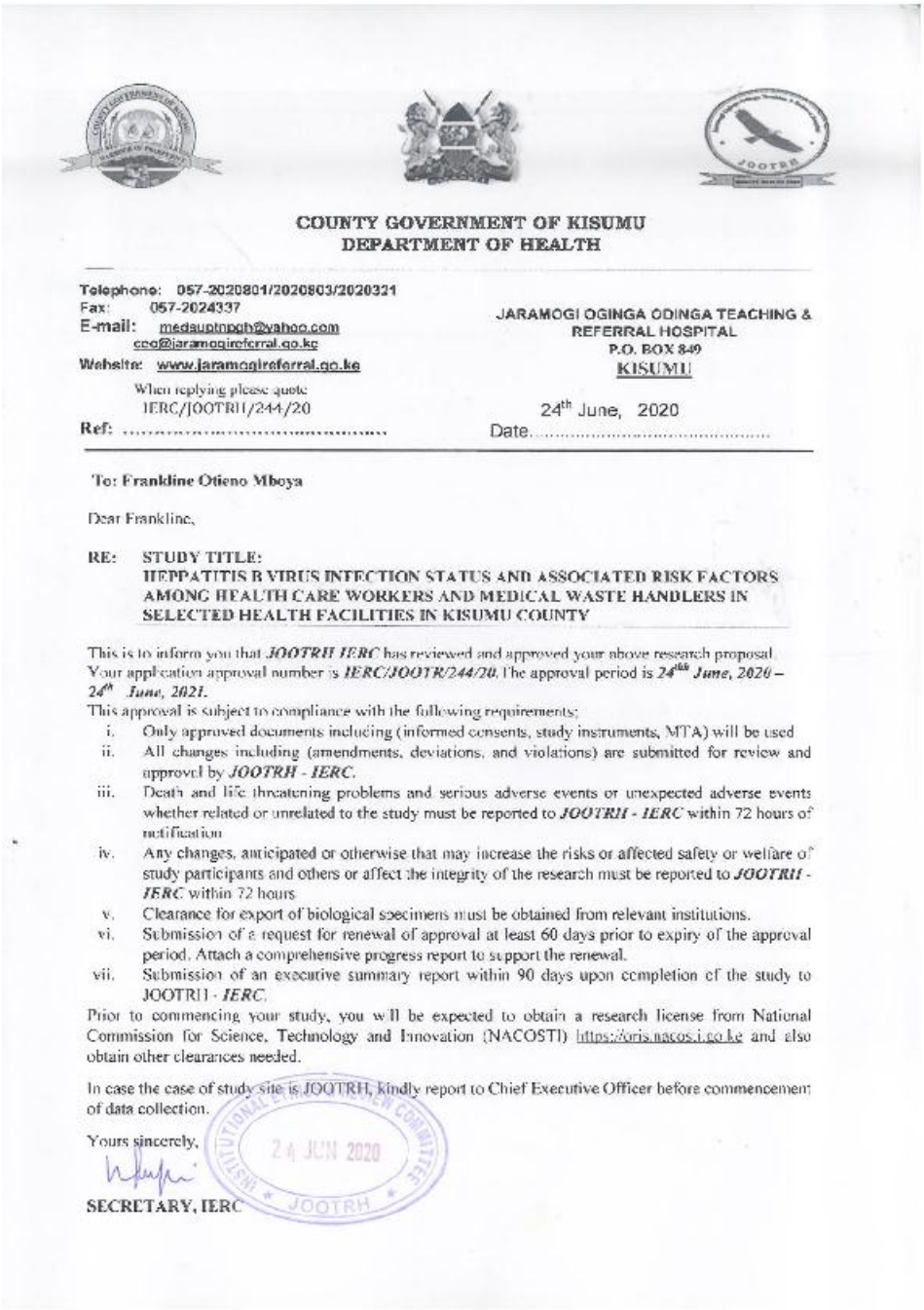
Any assistance accorded to him shall be appreciated.

Thank you.

JARAMOGI OGINGA ODINGA
DIRECTOR BOARD OF
POST GRADUATE STUDIES
DATE .....
P. O. BOX 210 - 40601, BONDO
UNIVERSITY OF SCIENCE & TECHNOLOGY

Prof. Dennis Ochuodho
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

Appendix 2: Ethics review board approval.



COUNTY GOVERNMENT OF KISUMU
DEPARTMENT OF HEALTH

Telephone: 057-2020801/2020803/2020321
Fax: 057-2024337
E-mail: medsuptnpgh@yahoo.com
ceo@jaramogireferral.go.ke
Website: www.jaramogireferral.go.ke

JARAMOGI OGINGA ODINGA TEACHING & REFERRAL HOSPITAL
P.O. BOX 849
KISUMU

When replying please quote
Ref: IERC/JOOTRH/244/20

Date: 24th June, 2020

To: Frankline Otieno Mboya

Dear Frankline,

RE: STUDY TITLE:
HEPPATITIS B VIRUS INFECTION STATUS AND ASSOCIATED RISK FACTORS AMONG HEALTH CARE WORKERS AND MEDICAL WASTE HANDLERS IN SELECTED HEALTH FACILITIES IN KISUMU COUNTY

This is to inform you that ***JOOTRH IERC*** has reviewed and approved your above research proposal. Your application approval number is ***IERC/JOOTR/244/20.*** The approval period is ***24th June, 2020 – 24th June, 2021.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***JOOTRH - IERC.***
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***JOOTRH - IERC*** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***JOOTRH - IERC*** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to JOOTRH - ***IERC.***

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

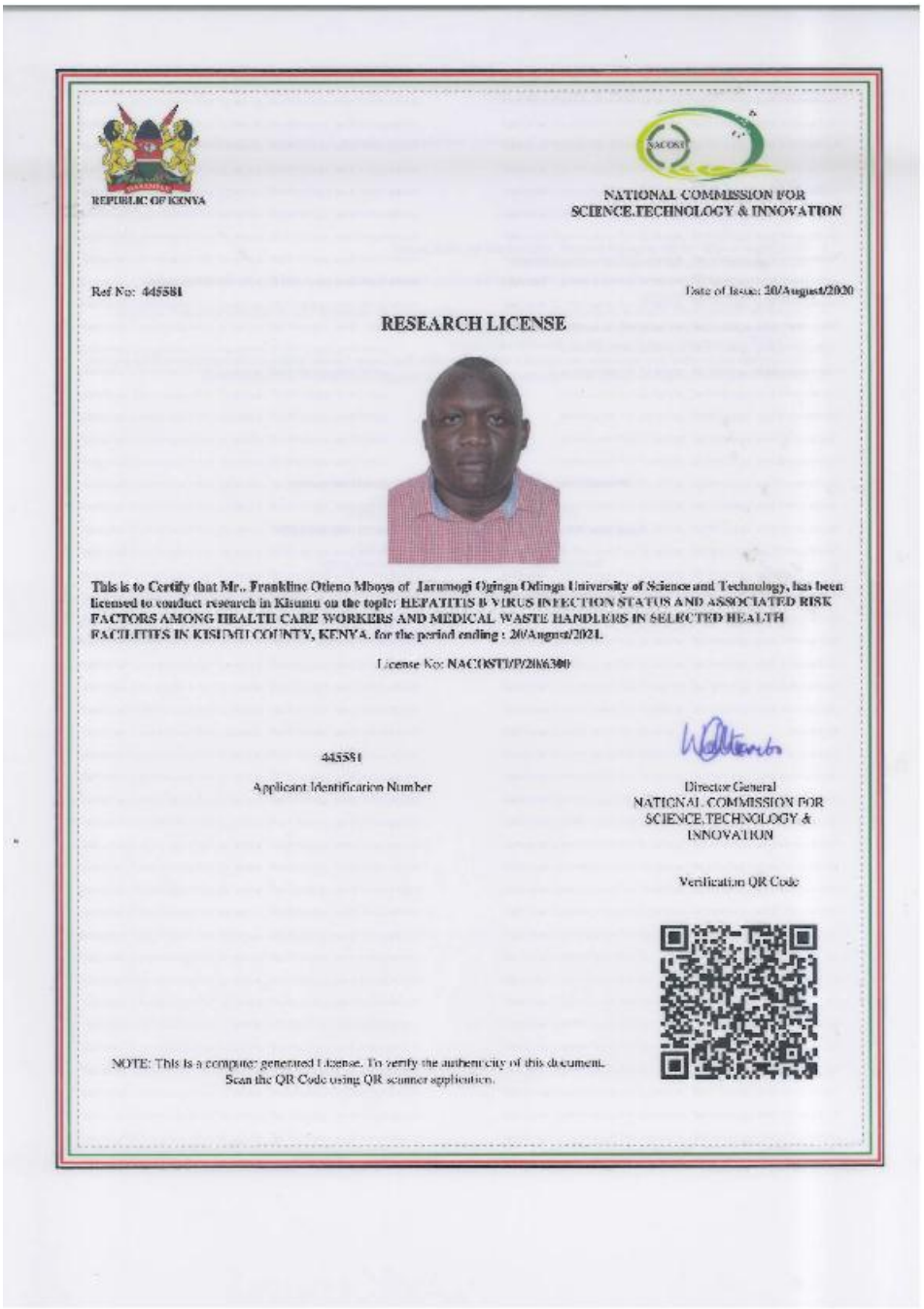
In case the case of study site is JOOTRH, kindly report to Chief Executive Officer before commencement of data collection.

Yours sincerely,

INSTITUTIONAL ETHICS REVIEW COMMITTEE
24 JUN 2020
JOOTRH

SECRETARY, IERC

Appendix 3: Research License



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 445581

Date of Issue: 20/August/2020

RESEARCH LICENSE

This is to Certify that Mr.. Frankline Otieno Mboya of Jaramogi Oginga Odinga University of Science and Technology, has been licensed to conduct research in Kisumu on the topic: HEPATITIS B VIRUS INFECTION STATUS AND ASSOCIATED RISK FACTORS AMONG HEALTH CARE WORKERS AND MEDICAL WASTE HANDLERS IN SELECTED HEALTH FACILITIES IN KISUMU COUNTY, KENYA. for the period ending : 20/August/2021.

License No: NACOSTI/P/20/6300

445581

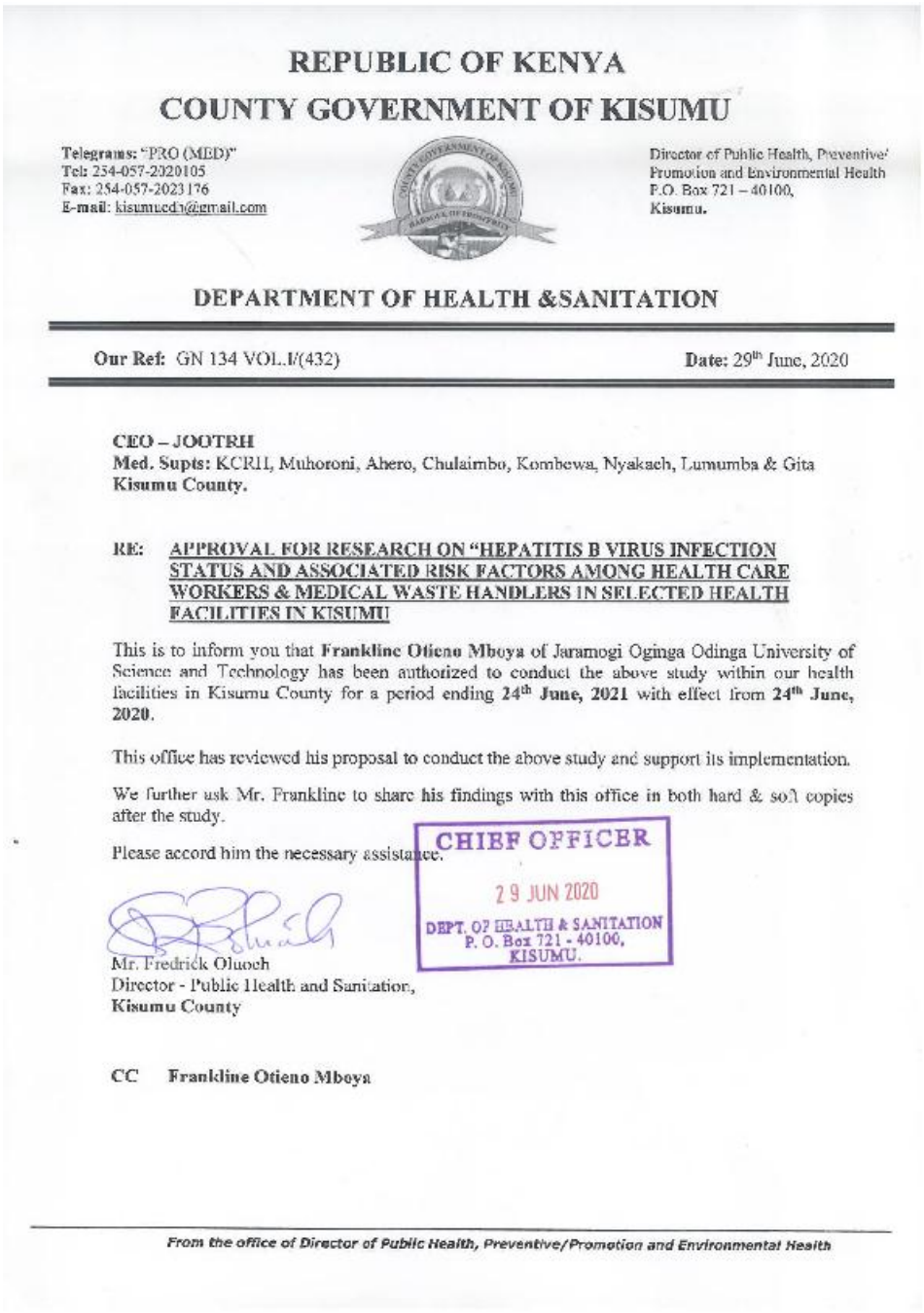
Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix 4: Authority to collect data from County Government of Kisumu, Department of Health.



REPUBLIC OF KENYA

COUNTY GOVERNMENT OF KISUMU

Telegrams: "PRO (MED)"
Tel: 254-057-2020105
Fax: 254-057-2023176
E-mail: kisumuedh@gmail.com

Director of Public Health, Preventive/
Promotion and Environmental Health
P.O. Box 721 – 40100,
Kisumu.

DEPARTMENT OF HEALTH &SANITATION

Our Ref: GN 134 VOL.I/(432) **Date:** 29th June, 2020

CEO – JOOTRH
Med. Supts: KCRII, Muhoroni, Ahero, Chulaimbo, Kombewa, Nyakach, Lumumba & Gita
Kisumu County.

RE: APPROVAL FOR RESEARCH ON "HEPATITIS B VIRUS INFECTION STATUS AND ASSOCIATED RISK FACTORS AMONG HEALTH CARE WORKERS & MEDICAL WASTE HANDLERS IN SELECTED HEALTH FACILITIES IN KISUMU

This is to inform you that **Frankline Otieno Mboya** of Jaramogi Oginga Odinga University of Science and Technology has been authorized to conduct the above study within our health facilities in Kisumu County for a period ending **24th June, 2021** with effect from **24th June, 2020**.

This office has reviewed his proposal to conduct the above study and support its implementation.

We further ask Mr. Frankline to share his findings with this office in both hard & soft copies after the study.

Please accord him the necessary assistance.

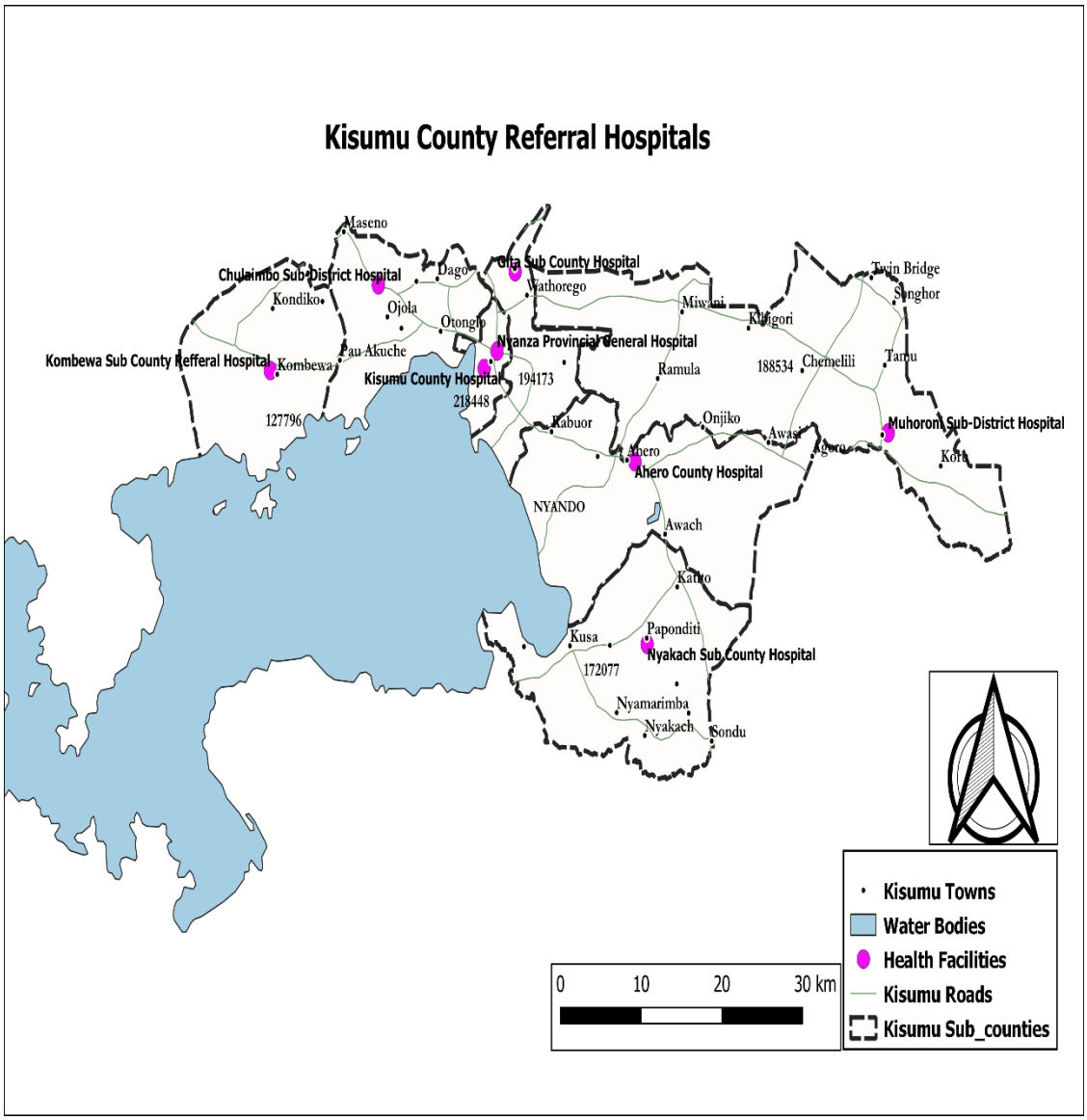
CHIEF OFFICER
29 JUN 2020
DEPT. OF HEALTH & SANITATION
P. O. Box 721 - 40100,
KISUMU.

Mr. Fredrick Oluoch
Director - Public Health and Sanitation,
Kisumu County

CC Frankline Otieno Mboya

From the office of Director of Public Health, Preventive/Promotion and Environmental Health

Appendix 5: Map of the study Hospitals.



Appendix 6: Informed Consent Form

Title: Hepatitis B Virus infection status and associated risk factors among health care workers and medical waste handlers in selected health facilities in Kisumu.

I am doing this study as **Frankline Otieno Mboya** master's school project to determine the Hepatitis B HIV virus infection status and associated risk factors among health care workers and medical waste handlers. This study will help us to determine the prevalence of HBV infections among health care workers (HCW) and waste handlers (MWH). Understand the HCW/MWH knowledge on waste management, risk of hepatitis B transmission and immunization status. Determine the distribution of hepatitis B infection in various sub county, county and teaching and referral hospitals in Kisumu County. Determine relationship between the positivity for HBV and age, gender, immunization status, occupation, and duration of exposure. If you decide not to take part, your normal work will not change. The information that you provide is very important for the Ministry of Health, county government of Kisumu and the study principal investigator as the evidence from this study apart from the academics benefit to the PI, the findings will be presented to public health officials, decision-makers, and other concerned bodies to inform the burden of HBV infection among the health care workers and recommend prevention measures amenable to our local health care settings.

Steps

We will ask a few short questions, like your name, age, your department of work, cadre, trainings undertaken, asses knowledge on (waste management, Personal Protective equipment, HBsAg etiology and prevention) and vaccination status, we will draw blood about 5.0 ml of venous blood in a 6.0 ml vacutainer tube with a clot activator from the consented study participants for Hepatitis B surface antigen (HBsAg), and hepatitis B surface antibody (anti-HBs) at KEMRI HIV R Laboratory. We will talk to you about the results and what it means, your results will also be given to you. I will put a serial number but not your name on the on the container with the blood. This will make sure your information is private.

Risk

If you take part, your risks are small. The tools we will use to collect blood are clean and safe. You may feel pain when your blood is taken. There may be a bruise. Please contact the clinic if you see any swelling where the blood was taken. **Gains**

The results may help develop better systems at our health facility for infection prevention and control to enable our health care workers and waste handlers have a better environment as they deliver the services to the clients. For those who test negative and have not been vaccinated, HBsAg vaccine will be given to them.

Confidentiality

Every effort will be made to keep your information private and risk of loss of confidentiality is minimal. Any sample from you or information about you will be identified only by code. The link between your name and code will be kept in a secure location and only a few study staff can have access to it to match up results if needed. We will not use your name or identify you personally in any report from this project.

Voluntary participation

Your taking part in the questionnaire and taking of blood for testing is voluntary. It is your own choice. You are free to not answer any of the questions for any reason at any time. You do not have to take part in testing if you do not want to.

You may stop taking part in testing at any time, without the risk of losing your work, your working schedule or working environment. There is no direct cost to you for taking part in this study.

If you feel, you have been harmed by taking part, or have any questions you may contact the Study PI:

Name	*Institution*	*Phone number*
Frankline Otieno Mboya	Study PI	0720304739

If you have any questions on what your rights are as a study participant, you may contact the Secretariat for the Ethical Review Committee:

Name	*Institution*	*Phone number*
JOOTRH ETHICS OFFICE	JOOTRH	0723421452/0733877977
JOUST ETHICS OFFICE	JOUST	

Do you agree to participate in this study? (Participant provides verbal response to study Research assistant Provider indicates response on the Recency Surveillance Form).

If you accept to participate sign here:

_____

Appendix 7: Instruction on filling data collection tool

Indicator definition _Hepatitis B Virus infection status and risk factors among health care workers and medical waste handlers in selected health facilities in Kisumu count Kenya

1. Serial Number: Put the serial number of the study participant, first letters 2 coded of the site followed by serial number. Site codes are as follows.
    1. JO- Jaramogi Oginga Odinga Teaching and Referral Hospital
    2. KC-Kisumu County referral Hospital
    3. MU- Muhoroni county Hospital
    4. AH-Ahero county Hospital
    5. GI-Gita Subcounty Hospital
    6. CH-Chulaimbo county Hospital
    7. NY-Nyakach county hospital
    8. KO-Kombewa subcounty Hospital
    9. LU-Lumumba sub county Hospital

Example The first study participant in Kisumu County Hospital is KC- 0001/20, the numbering continues serially till the last participant.

2. Health facility- Indicate the name of the health facility where the study is curried in
3. Participant name – Indicate the full name of the study Participant
4. Department – Indicate the health department where the study participant work
5. Date of birth-Indicate the date of birth of the participant i.e. DD/MM/YY
6. Sex _ Indicate the study participant sex i.e. M for Male and F for female
7. Carder _Indicate N for nurses, C for clinical officers, L for lab techs, D for doctors, and MW for medical waste handlers.
8. Consented- Indicate Y if client has consented, N if Not given consent, NC if not given consent. Indicate Y if 6 ML sample collected and P if sample was collected but not 6 ML and N if sample was not collected.
9. Vaccinated before – Indicate Y if ever vaccinated and N if never vaccinated.
10. Dose completed- Indicate Y if dose completed and N if not completed.
11. Dose not completed- Indicate the doses received in numerical i.e. 1,2,1&2,
12. History of Exposure- Indicate NS if had needle stick injury, CN if had contact exposure, N if no any known exposure.

13. PPE Available- Indicate Y if all the PPE are available-N if not available (Medical personnel (Gloves, Sharp containers) Waste handlers (Aprons, Heavy duty gloves)
14. PPE adequate Indicate if the PPE is adequate for all the personnel in the rotter.
15. Training on PPE done-Indicate Y if full module of training on PPE was done including demonstration, O if only orientation was done and no demonstration, D if demonstration only was done, N if there was no any form of training.
16. Training on infectious agent in Waste_ Indicate if training has been done on infectious agent in waste; Indicate Y if full module of training on infectious agent in waste was done, O if only orientation was done, N if there was no any form of training.
17. Training on Waste Management. Indicate Y if full module of training on waste management was done including demonstration, O if only orientation was done and no demonstration, D if demonstration only was done, N if there was no any form of training.
18. Results _ HBsAg _ Indicate P if positive for HBsAg, N if Negative for HBsAg and I if indeterminate.
19. Results _anti HBs__ Indicate P if positive for HBsAg, N if Negative for HBsAg and I if indeterminate
20. Consented for vaccination _ Indicate NC if no consent for vaccination and C if consented for vaccination
21. Vaccinated today_ Indicate Y if vaccinated and N if not vaccinated
22. 0 month _Indicate lot number of the vaccine and expiry date, from row number 8 downwards put date DDMMYYYY of 1st vaccination if the vaccination was done and N/A if vaccination was not done
23. 1 month _Indicate lot number of the vaccine, expiry date, from row number 8 downwards put date DDMMYYYY of 2nd vaccination if the vaccination was done and N/A if vaccination was not done
24. 6month Indicate lot number of the vaccine, expiry date, from row number 8 downwards put date DDMMYYYY of 3rd vaccination if the vaccination was done and N/A if vaccination was not done
25. Vaccination card given_ Indicate Y if vaccination card was given and N if vaccination card was not given.
26. Daily waste Segregation _Indicate Y if waste is segregated daily N if waste is not segregated daily.

27. Waste disposable method _ Indicate I if infectious waste if incinerated, O if open burning, B if burying and R if recycled.
28. Comment _ indicate any other comments you may be having.

Appendix 8: List of Facilities Visited

The following Health facilities were visited for this study.

1. Jaramogi Oginga Odinga Teaching and Referral Hospital
2. Kisumu County referral Hospital
3. Muhoroni county Hospital
4. Ahero county Hospital
5. Gita Subcounty Hospital
6. Chulaimbo county Hospital
7. Nyakach county hospital
8. Kombewa subcounty Hospital
9. Lumumba sub county Hospital

Appendix 9: Data Collection tool

Serial Number	Date	Health Facility name	Client Name	Age	Sex	Carder	Consented	Sample collected	Vaccinated before?	if yes completed dose?	if no vaccinated # dosses received	PPE available in the hospital	PPE adequate	History of needle stick injury	History of contact exposure	Training on PPE usage	Training on infectious agent in waste	Training on waste management	Daily waste segregation	Infectious waste incinerated	Results HBsAg	Results for anti HBs	Results for anti HBc	Comments