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Original article

Unsafe sexual practices prior to incarceration, and early childhood transmission are potential high-risk factors of Hepatitis B and HIV infection among prisoners in Blantyre, Malawi

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ABSTRACT

Background: Hepatitis B and C viruses (HBV/HCV) are the major causes of liver diseases primarily transmitted through contact with infected blood, and body fluids. Prison settings are a significant driver of blood-borne viruses among prisoners during detention and after release. **Aim:** The primary aim of this study was to assess the prevalence of HBV, HCV and HIV among those detained at Chichiri prison. **Methods:** The study enrolled 220 participants at Chichiri prison. A structured questionnaire was used for collection of demographic details, assessment of knowledge, and risk factors for transmission of viral hepatitis in prison environment in Malawi. Serum samples were prepared and analyzed utilizing HBV, and HCV rapid assays. All positive samples were run on sandwich enzyme immunoassay (EIA). **Results:** The HBV prevalence was estimated at 8.6%; whereas HCV was not detected in any sample (0%). The HIV prevalence rate was 21%, and HBV/HIV co-infection prevalence was 11%. The majority (79.1%) of prisoners were incarcerated between 2017 and 2020. **Conclusion:** This study confirms high prevalence of HBV among prisoners at Chichiri. Findings suggest that intra-prison viral hepatitis transmission was very minimal, possibly due to criminalisation of high-risk practices (injecting drug use, sex between men) for exposure to blood-borne viruses. Sexual transmission prior to incarceration was presumably the highest risk factor for viral hepatitis and HIV. Prison environments present both challenges and opportunities for prevention and treatment of viral hepatitis and HIV infections.

Introduction

Hepatitis B virus (HBV) and Hepatitis C virus (HCV) are major causes of acute and chronic liver disease that lead to cirrhosis and hepatocellular carcinoma (HCC) [1]. The World Health Organization (WHO) set an ambitious target to

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achieve 65% reduction in liver-related deaths, a 90% reduction in viral hepatitis incidence rate, and 90% of patients with viral hepatitis infections being diagnosed between 2016 and 2030. It was recommended that all countries design and implement viral hepatitis control and elimination programs [2–4]. Low and middle-income generating countries particularly in Africa have disproportionately high rates of chronic HBV and HCV especially in populations exposed to high-risk practices [4]. Injecting drug use was reported as a common route for transmission of HCV in Middle East and North Africa (MENA) [5] [6]. A household study conducted in Blantyre Malawi reported a hepatitis B surface antigen (HBsAg) seroprevalence of 5.1% [7] and HCV RNA prevalence of 0.2% [8]. Early screening and diagnosis of HBV and HCV is the gateway for access to both prevention and treatment services and an essential component of an effective response to hepatitis epidemic [4] [9].

Hepatitis refers to the inflammation of the liver which can be caused by toxins, drugs, chemicals, heavy alcohol use and other metabolic and genetic disorders. In Africa and Asia, HBV and HCV infections remain a serious global public health concern and major causes of morbidity and mortality [10] [11]. Late diagnosis and delayed treatment of viral hepatitis infection can lead to the development of liver cirrhosis, HCC and permanent liver damages [12,13]. Viral hepatitis remains one of the most important causes of mortality and morbidity whose absolute global burden has increased over the years [14].

HBV which is a double stranded deoxynucleic acid (dsDNA) virus is mainly spread percutaneously, and mucosal exposure to infected blood or other body fluids, at birth or in infancy. The risk of HBV progression to the development of chronic HBV infection is highest after viral transmission either vertically (mother to child) or horizontally (early childhood) during the first 5 years of life. Global prevalence of HBV infection in under-five children was estimated at 1.3% [15] [16]. Universal HBV immunization at birth and in infancy has been highly effective in the reported reduction of incidence rates of mother-to-child transmission [17].

The WHO estimates that over 354 million people are living with viral hepatitis globally with 70 million people affected in Africa (60 million due to HBV and 10 million due to HCV). In Malawi the HBV prevalence varies greatly, where 17.5% of medical inpatients were reported to be infected with HBV. The HBV/HIV co-infection was estimated at 20.4% [18]. Among people living with HIV in Africa, it was estimated that between 6% and 25% were co-infected with HBV [19] [20]. Since 1982, HBV can be prevented through vaccination (offers 98 – 100% protection against hepatitis B infection) [21]. The HCV prevalence among prisoners was estimated to range from 3.1% to 38% worldwide [21]. In 1991, the WHO recommended introduction of universal HBV immunization in all countries. In 2002, Malawi adopted the HBV universal vaccination program [22].

HCV is a single stranded positive sense RNA (+ssRNA) virus that belongs to Flaviviridae family. Injection drug use through sharing of infected needles and other paraphernalia remains the primary risk factor for HCV transmission in developed world whereas sexual contact could be the highest risk factor in low-income countries. Similar to HBV, HCV is also spread through contact with infected blood and other body fluids [23]. In 2022, the WHO report indicated that approximately 58 million people were living with HCV, with nearly 299,000 people die due to HCV related liver diseases [24]. Since there is no effective vaccine for HCV due to high degree of strain variation and lack of animal model, the primary preventive measures focus on reducing risks of infection through safe injections and blood safety. Historically, countries in Africa and Asia have the highest reported Anti HCV prevalence that attributes to 25% of HCC cases [25]. In Malawi, the pooled HCV prevalence estimates varied from 0.7-18.0% [26]. Around 80% of individuals exposed to HCV develop chronic infection, 3-11% of those with chronic infection will develop liver cirrhosis within 20 years with an associated risk of liver failure and HCC [27] [28] [23].

Prisons and other detention settings, present opportunities for transmission and acquisition of blood-borne viruses including HBV, HCV and Human immunodeficiency virus (HIV) during detention and after release [29] [30] [31]. It has been estimated that over 1.5 million prisoners (15% among prison population) are living with HCV globally, though marked with regional variations; whereas nearly 25% of the prison population are living with chronic HBV in west and central Africa [31]. The increased burden of viral hepatitis and other blood-borne infections among

prisoners has been attributed to different social and behavioral factors that include unprotected same-sex sexual activities, injection drug use (IDU) as well as lack of medical advice after incarceration [32] [33].

Prison environment is associated with higher frequencies of high-risk behaviors such as injection drug use, unprotected multiple partner homosexual activities, unsafe tattooing, needle sharing and rape which exposes the inmates to viral hepatitis and HIV infections [34] [35]. However, these risky behaviors may precede imprisonment and frequently continue during incarceration. Prisoners are among the high-risk groups for blood-borne infections because they live in groups of people with high-risk behaviors. The prevalence rate for viral hepatitis and HIV was reported to be high in some countries including a previous study conducted by Chimphambano in Malawi (HBV and HIV was estimated at 3.5% and 36.6% respectively) [21] [35]. The majority of prisoners (10 – 60%) have a history of injection drug use that were reported to be infected with viral hepatitis [36]. Chimphambano et al studied risk factors for viral hepatitis among prisoners [35]. Therefore, it was imperative to evaluate the risk of viral hepatitis and HIV to assess some changes during the last decade.

Despite the Chimphambano study in 2007, there is scarcity of information related to prevalence and risk factors for HBV, HCV and HIV among prisoners in Malawi. The national epidemiology of viral hepatitis is not well known except that of HIV and acquired immunodeficiency syndrome (AIDS). We conducted a cross-sectional observational study aimed at investigating the seroprevalence of viral hepatitis and HIV among prisoners in Malawi and to estimate the burden of the disease at Chichiri prison. Since these viruses share some similarities in their transmission dynamics, this study offered an opportunity to study the risks for mono- or co-infections and describe the general prevalence of blood-borne viruses in prison setting in Malawi.

Materials and Methods

A cross-sectional observation study was conducted in 2019 among prisoners at Chichiri prison, Blantyre Malawi. Chichiri is the largest prison in the Southern region of Malawi housing over 2000 prisoners. Permission was sought from the Commissioner of Prisons. All study participants provided written informed consent for participation, including storage of blood samples for future studies. Ethical clearance (study number UP.10/19/2811) was sought from the College of Medicine Research Ethics Committee (COMREC), privacy and confidentiality were observed during the study. The study participants fulfilled the following eligibility criteria: substantial long duration of incarceration (more than 6 months) and substantial history of exposure to high-risk factors for viral transmission such as injection drug use, unsafe sexual practices, sharing of injection paraphernalia, blood transfusion, tattooing etcetera.

Based on the estimated number of 2000 prisoners, and the previous estimates of HBV (3.5%) and HIV (36.6%) prevalence, all study participants identification and recruitment followed a non-probability convenience sampling. We estimated a sample size using a conservative prior prevalence estimate of 8.6%, and 21% for HBV and HIV respectively with a 95% confidence interval, giving a sample size requirement of 220. Following dissemination of written study information, 220 inmates provided a written consent, were interviewed and submitted 10 ml of whole blood sample for HBV, HCV, and HIV testing ensuring that confidentiality of the collected information was maintained throughout the study period and after. A semi-structured questionnaire was used to assess risk of exposure prior to incarceration or within closed prison facilities in Malawi. The collected information included: socio-demographic data, risky behaviors practiced in the prison, and knowledge of HBV, HCV and HIV infections. A pretest questionnaire was administered to the eligible participants with assistance from the Chichiri prison's Clinical Officer, where data about social demographic variables, history of viral exposure, injection drug use, and sexual behavior was obtained.

10 ml of blood samples were collected in plain and EDTA tubes in equal volumes. Samples were transported in biohazard boxes to the Training Research Unit of Excellence (TRUE) laboratory at College of Medicine where they were centrifuged at 3000 revolutions per minute (rpm) for 15 minutes for separation of serum and plasma from the cells. The serum and plasma samples were stored in a –20 °C freezer according to standard procedures and later taken to Johns Hopkins Research laboratory (JHP) for HBsAg, anti-HCV and anti-HIV screening utilizing HBV Premium way International, UK), INTEC (Code No: ITP01102-TC40, China), and ALLERE rapid diagnostic test (RDT) kits respectively. The RDTs for detection of HBsAg,

and anti-HCV ab had a manufacturer's average sensitivity and specificity of 100% and 99% respectively. The RDT testing followed detailed standard operating procedures (SOPs), as provided by the manufacturer. Results were interpreted 15 minutes after a drop of sample was added on the test strip. No results were interpreted after 30 minutes. The HBV RDT positive serum samples were tested for HBsAg using a second-generation enzyme-linked immunosorbent assay (ELISA) to confirm the presence of HBV surface antigens (HBsAg) in accordance with the manufacturer's instructions.

A questionnaire was used to collect socio-demographic data from the participants and this was assembled into an Excel sheet and transferred to SPSS (version 23) and STATA (version 16) statistical software for generation of graphs and tables. Demographic data was analyzed using Fisher exact test or the Chi-Square test for detection of frequencies, percentages and their associated p-values.

Results

Demographic Characteristics

A total of 220 inmates participated in the study of which 86.4% (n=190/220) were males. Majority (96.8%) of the inmates were between the age range of 18 – 65 years. A total of 179 inmates (81.4%) had 1 – 3 years of incarceration, whereas 3 (1.4%) had the longest service in prison (9 – 13 years), and 42 (19.1%) had a history of HBV vaccination (Table 1).

HBV, HCV, and HIV testing

Serum samples were screened for the presence or absence of HBsAg, anti-HCV and anti-HIV markers using RDT assays. All positive and inconclusive/indeterminate results (i.e. neither clearly positive nor negative) were confirmed with an ELISA assay. Of the 220 participants, 19 (8.6%) tested positive for HBsAg, only 1 participant (0.5%) had indeterminate results which were repeated on ELISA together with all positive samples. Of the 20 samples (18 HBV positive, 1 inconclusive) that were repeated for ELISA, 19 were confirmed positive, the indeterminate sample tested positive, that gave an overall HBV prevalence rate of 8.9% (n=19/220) (figure 1).

Of the 19 HBsAg HBV positive samples, the ELISA assay confirmed 15 positives, suggesting that 4 samples were false positives by the HBV RDTs. From the negative samples, the HBV HBsAg ELISA detected 3 positives which means that they were false negatives by the HBV RDTs. The indeterminate sample eventually tested positive by the HBV HBsAg ELISA assay. Thus, 8.6% (n=19/220) of serum samples were confirmed HBV HBsAg positive utilizing the ELISA assay. Females had a high positivity rate (13.3%, n=4/30) as opposed to males (7.6%, n=15/190). Of the 19 HBV positive cases, 52.6% (n=10/19) were married, 42.1% (n=8/19) were divorced, and 5.3% (n=1/19) were single (Table 2).

Furthermore, of the 220 recruited study participants, only 100 serum samples were screened by RDTs assay for anti-HCV antibodies due to inadequate resources. Of these, 85% (n=85/100) serum samples were re-tested utilizing the ELISA assay to rule out false negatives. None of the samples analysed tested positive for HCV (100% negativity) for either RDTs or ELISA assays.

Comparatively, HIV screening was performed on 62 serum samples utilizing RDTs where 21% (n=13/62) were reported HIV-positive. Additional HIV sero-status details were collected through a semi-structured questionnaire as well as from participants' health passports. Of the 220 study participants, only 122 had known HIV history (data collected from health passports). Of the 122 records, 59 participants were known HIV positive cases based on ART records. Accordingly, those that were tested HIV positive (21%, n=13/62) in this study coupled by those that had a known HIV positive history (n=59/122), the overall HIV prevalence rate at Chichiri prison was estimated at 39.1% (72/184). Note that participants who had a known HIV positive status were on antiretroviral therapy (ART) through the 'Test and Treat' universal treatment policy adopted throughout sub-Saharan region. Of the 19 prisoners that tested positive for HBV HBsAg, 10 of them were coinfected with HIV. For this reason, the HBV/HIV coinfection rate was estimated at 11%.

Furthermore, 12% (n=3/25) of inmates who had a history of blood transfusion, tested positive for HBV, and 14.5% (n=9/62) had HIV mono-infection. None of HBV vaccinated inmates had HBV infection, however, 12.9% (n=8/62) had HIV infection. In contrary, 5.1% (n=9/178), 87.1% (n=54/62), and 100% (n=10) of unvaccinated inmates had HBV mono-infection, HIV mono-infection and HBV/HIV co-infection respectively.

Of note, all the HBV/HIV co-infected individuals (n=10), had strong association with male

gender, young age (18 – 65 years), married, unvaccinated, more than 1 sexual partner, and duration of incarceration (1 – 5 years); where 80% were on antiretroviral medications. 100% had no HCV infection following HCV antibody screening utilising RDT

Table 1. Demographic details of the study participants (n=220).

Characteristics		**Number of participants (%)**
Gender	Male Female	190 (86.4%) 30 (13.6%)
Age (yrs)	18 – 65 >65	213 (96.8%) 7 (3.2%)
Residence	Northern region Central region Southern region	3 (1.4%) 13 (5.9%) 204 (92.7%)
Years of incarceration	9 – 13 4 – 8 1 – 3	3 (1.4%) 38 (17.3%) 179 (81.4%)
HBV vaccine history	Vaccinated Unvaccinated	42 (19.1%) 178 (80.9%)

Table 2. Demographic and behavioral characteristics in accordance with HBV, HCV, and HIV sero-status (frequency, percentage and their associated p-values).

Variable		**No Infection**	**HBV Mono-infection**	**HBV Co-infection**	**P-Value**
Gender	Male	175 (87.1)	6 (75.0)	9 (81.8)	0.562
	Female	26 (12.9)	2 (18.2)	2 (25.0)	
Age (years)	18-65	194 (96.5)	8 (100.0)	11 (100.0)	0.711
	>65	7 (3.5)	0 (0.0)	0 (0.0)	
Marital status	Single	89 (44.3)	3 (37.5)	6 (54.6)	0.736
	Married	112 (55.7)	5 (62.5)	5 (45.5)	
History of blood transfusion	Yes	22 (11.0)	2 (25.0)	1 (9.1)	0.457
	No	179 (89.1)	6 975.0)	10 (90.9)	
HBV vaccine history	Vaccinated	42 (20.9)	0 (0.0)	0 (0.0)	0.086
	Unvaccinated	159 (79.1)	8 (100.0)	11 (100.0)	
Sexual contact in prison	Yes	3 (1.5)	0 (0.0)	0 (0.0)	0.866
	No	198 (98.5)	8 (100.0)	11 (100.0)	
Sexual partners	<=1	48 (23.9)	2 (25.0)	1 (9.1)	0.523
	>1	153 (76.1)	6 (75.0)	10 (90.1)	
Drug injection	Yes	3 (1.5)	0 (0.0)	0 (0.0)	0.866
	No	198 (98.5)	8 (100.0)	11 (100.0)	
Duration of incarceration (yrs)	1 – 5	208 (94.5)	191 (91.8%)	8 (3.8%)	0.504
	6 – 10	10 (4.5)	8 (80%)	1(10%)	
	> 10	2 (1.0)	2 (100%)	0 (0.0)	
HIV Status	Negative	83 (41.3)	1 (12.5)	0 (0.0)	<0.001
	Positive	51 (25.4)	0 (0.0)	8 (72.7)	
	Unknown	67 (33.3)	7 (87.5)	3 (27.3)	

Notes: *HCV testing was performed on 100 samples. Numbers in parenthesis are percentages.

Figure 1. Study recruitment and testing.

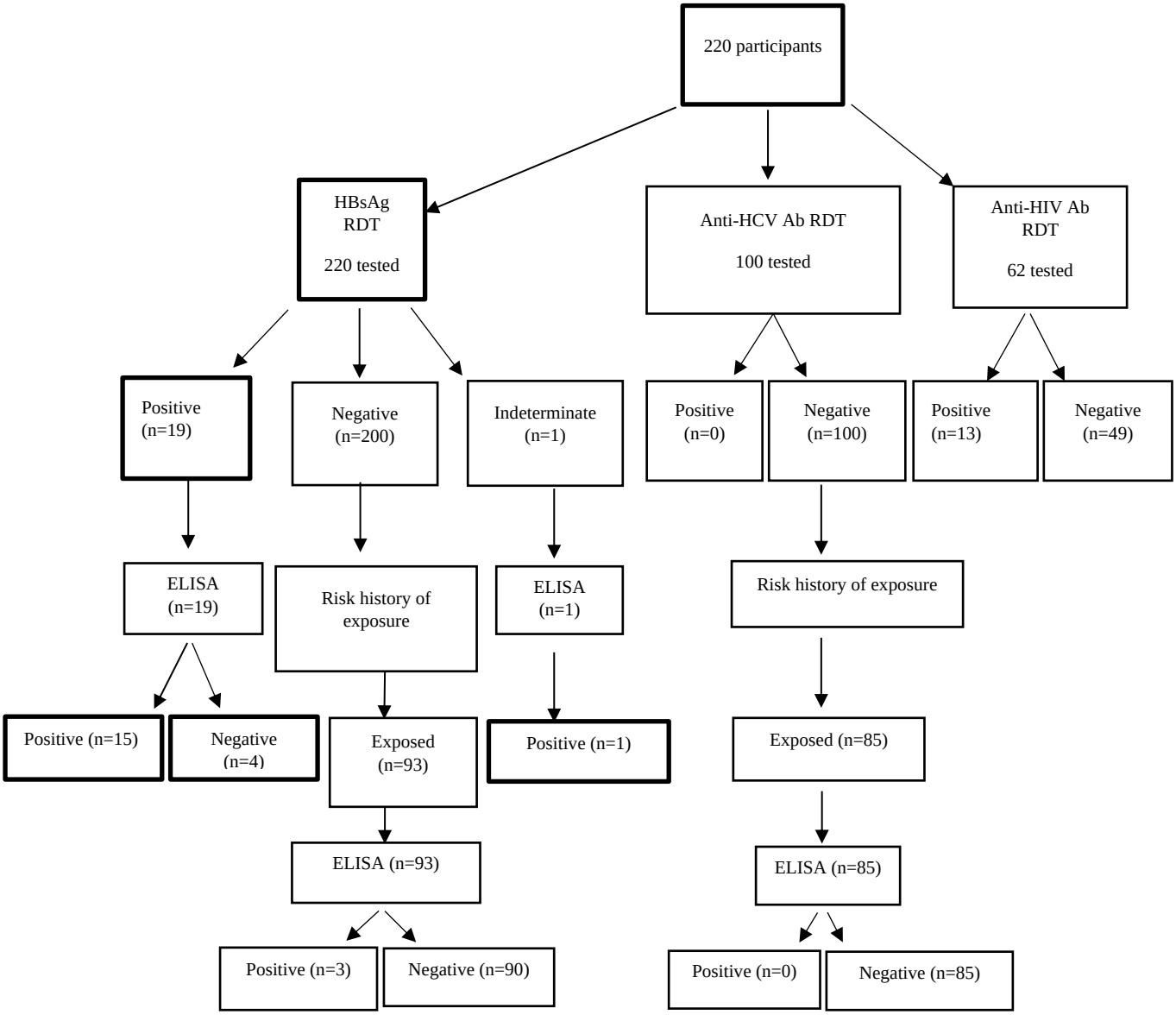

Figure 1. shows a flow chart detailing recruitment of study participants tested for HBsAg, Anti-HCV Ab, and Anti-HIV Ab. This figure shows a pathway of how samples for 220 study participants were tested using HBsAg, Anti-HCV Ab, and Anti-HIV Ab RDT test kits. Risks of exposure to HBV and HCV viral particles was determined using a questionnaire, and the number of potentially exposed participants was recorded in this figure. All participants who were HBsAg and Anti-HCV Ab negative were also tested with ELISA.
Abbreviations: HBsAg = Hepatitis B surface antigen, RDT = Rapid diagnostic test, ELISA = Enzyme-linked immunosorbent assay, HBV = Hepatitis B virus, HCV = Hepatitis C virus, HIV = Human Immunodeficiency virus, Ab = antibody.

Discussion

This study of 220 incarcerated individuals at Chichiri prison in the southern region of Malawi, we found a high burden of HBV/HIV infections among prisoners with HBV HBsAg and HIV estimated at 8.6% and 39.1% respectively. These HBV findings are slightly high whereas the HIV findings are comparable to Chimphambano's findings of HBV (3.5%) and HIV (36.6%) [35]. This highlights the observation that the HBV and HIV prevalence has remained worrisomely high in prison settings in Malawi over the past decade. The HBV

and HIV prevalence rates reported in this study are higher than in the general population (HBV – 8.1%; HIV – 9.2%) [37]. This suggests that imprisonment conditions remain one of the high risky areas for transmission of blood-borne viruses. This study did not establish that viral transmission occurred within prison confinement. This data confirms that prisoners are particularly vulnerable to blood-borne viral infections; therefore, information on prevention must be disseminated in prisons.

A study conducted in Belgian prisons reported HBV, HCV, and HIV prevalence rates of 0.8%, 5.0%, and 0.2% respectively [38]. Comprehensive systematic review conducted by Heijnen et al in Middle East and North Africa (MENA) reported injection drug use, tattooing, and sharing of non-sterile injecting equipment to be independent risk factors for HIV and HCV infections [39]. Low levels of sexual activities in prison was reported in MENA (1.5%) as opposed to Europe and North America (12.1%), and West and Central Africa (13.6%) [40].

In this study, the majority (86.4%) of the participants enrolled were males. However, females had a higher HBV infectivity rate (10%) as opposed to males (3.1%). This agreed with Chimphambano's study [35]. On the contrary, males had higher HIV infectivity rate (85.5%) than females (14.5%). This could be attributed to unsafe multiple sexual partners which is culturally acceptable in some communities, or infidelity.

Over the years, Malawi made impressive progress in controlling the HIV pandemic. However, despite such commendable efforts, the HIV prevalence among adult population (aged 15 – 49) is comparatively high (estimated at 9.6%) [37] [41]. The young population remains a concern. Malawi is still on track towards meeting the United Nations Programme on HIV/AIDS (UNAIDS) ambitious 95-95-95 targets aiming to end the AIDS pandemic by 2030 by detecting 95% of people living with HIV (PLHIV), 95% on treatment, and 95% achieve viral suppression [42]. However, a 2024 report indicates that the world is not on track to success because the HIV infections are not declining fast enough [43]. It is globally accepted that injection drug use is the dominant risk factor for HBV and HCV transmission; however, our study did not find any viral infections among the three people who inject drugs (PWID). Therefore, findings of this investigation speculate that sexual contact, including same sex activity in prisons was not the highest risk factor for HBV transmission in Malawi. This study showed the association between HBV exposure and young age (18 – 65 years), multiple sexual partners, being married, blood transfusion, and lack of HBV vaccination history. Unnaturally, the common risk factors for HBV transmission such as injection drug use, length of incarceration, sharing of contaminated needles, and HIV positivity were not significantly associated with HBV infection. In contrary, a study done by Marco et al in Brazil among male prisons, showed the association between HCV exposure and increasing age, injection drug use, length of incarceration, smoking, sharing needles and syringes and HIV positivity [34] [44].

Vertical and horizontal transmission were reported by others as the main avenues of HBV transmission that potentially lead to the development of chronic HBV infection in adulthood [15]. Based on our findings, we believe that the majority of HBV and HIV infections were acquired prior to incarceration either through vertical and horizontal early childhood transmission or sexually in adulthood. This is possibly due to criminalization and prohibition of behaviours that put one at risk of acquiring the blood-borne viral infections in Malawi prison settings. Furthermore, the actual prevalence of some risky behaviours could be higher at Chichiri prison but the under-reported numbers may be due to stigma and discrimination associated with such malpractices. Other studies also reported criminalization and stigma in the general population [45] [46] [47]. Little is known about experiences of stigma or unfair treatment perpetrated against prisoners and other people belonging to disadvantaged social groups in Malawi. This however underscores that in some communities including prison settings, some study participants may not provide accurate information of their sexual behaviours due to the sensitive nature of such practices, and their associated stereotypes.

Malawi established a centre (Malawi Blood Transfusion Service – MBTS) to ensure supply of safe blood [48]. Despite this initiative, some hospitals continue to screen and collect blood from potential donors. The safety of such blood donation is not a guarantee due to usage of invalidated screening methods. However, M'baya et al. recommended use of the WHO Haemoglobin Colour Scale (HCS) for donor screening. This method was comparatively cost-effective, and could offer a potential solution to a critical shortage of

blood supply to prevent maternal haemorrhage deaths [49] [50] [35]. In this study, 12% of inmates who had a history of blood transfusion, tested positive for HBV, and 14.5% had HIV mono-infection. None of HBV vaccinated inmates had HBV infection, however, 12.9% had HIV infection. On the contrary, 5.1%, 87.1%, and 100% of unvaccinated inmates had HBV mono-infection, HIV mono-infection and HBV/HIV co-infection respectively.

Importantly, all the HBV/HIV co-infected individuals (n=10), had strong association with male gender, young age (18 – 65 years), married, unvaccinated, more than 1 sexual partner, and duration of incarceration (1 – 5 years); where 80% were on antiretroviral medications. HBV and HIV share a common mode of transmission, therefore unsafe sexual practice was observed as the highest risk factor for HBV and HIV transmission. This observation does not rule out the potential vertical and horizontal transmission in early childhood since this is one of the main routes of HBV transmission. There was no case of HCV infection reported in this study. The findings agreed with the previous study at Chichiri prison. This was expected, since HCV prevalence in Malawi was presumed to be very low [51]. This calls for a national HCV surveillance and screening programmes to establish an accurate estimation of HCV prevalence in Malawi.

Other studies also reported an association between sexual activities and transmission of viral hepatitis infections [52] [53]. These findings highlight absence of injection drug use as a primary risk behaviour for HBV and HIV transmission among prisoners in Malawi, contrary to other studies elsewhere that described IDU as the main mode of viral hepatitis infection [54] [55] [56]. Interestingly, older age could be an independent risk factor for HIV mono-infection. All variables applied in this study related to penal status. There was a small proportion of HBV/HIV co-infected individuals possibly due to different dynamics in viral transmissions and development of viral infections. A high proportion (76.8%, n=169/220) of the inmates had reported having more than 1 sexual partners; whereby 3.5% and 5.9% of them had HBV mono-infection and HBV/HIV co-infection respectively suggesting a high level of risky unsafe sexual behaviour among those detained in Malawi prisons.

There were several limitations to the study which included limited resources which reduced the sample size for both HCV and HIV testing. Inability to conduct additional testing for detection of HBV markers such as hepatitis B surface antibody (anti-HBs), and hepatitis B core antibody (anti-HBc) that offer an immune correlate of protection and an indication of past or current infection, obscured essential insights this study could have provided. Another factor that may limit the validity of the study conclusion was small sample size, and possibility of recall bias by the study participants. Due to limited resources, HBV DNA could not be measured utilising a confirmatory method such as nucleic acid amplification test (NAAT). It was observed that 61.2% of the participants reported no knowledge of risk factors for viral hepatitis transmission. Therefore, no or little knowledge on hepatitis infection might be one of the contributing factors for high HBV/HIV prevalence in prison setting.

The association between risky sexual contact and HBV/HIV infections in this population was strong, suggesting that it may be the primary route of viral transmission among people detained in Chichiri prisons. Since this was a cross-sectional observational study, therefore, determination of whether HBV/HIV infections were acquired before or within imprisonment settings is complex and speculative. The stigma associated with criminalisation and stigmatisation of same sex behavioural practices, recall bias, and cultural conditions, and imprisonment could potentially affect the under-reporting of some risky behaviours. Although prison environments is one of the high-risk places for transmission of blood-borne infections, they also enable easy implementation of appropriate public health interventions.

Conclusion

In this study, the HBV and HIV prevalence were estimated at 8.6% and 39.1% respectively among inmates at Chichiri prison in Blantyre Malawi, highlighting prisoners as a high-risk group for both HBV and HIV transmission. The risky sexual practices prior to incarceration that include having unprotected multiple sexual partners led to increase in strength of association with HBV/HIV mono- or co-infections. Absence of HCV markers reported in this study was expected since the HCV prevalence in general population was apparently very low. An exigent consideration of vertical and

horizontal HBV transmission to be performed in future studies to provide further insights into the viral transmission dynamics.

Declarations

Ethics approval and consent to participate

Ethical permission to conduct this study was obtained from College of Medicine Research Ethical Committee (Reference number: UP.10/19/2811). A written informed consent for participation, including storage of blood samples for future studies was sought from study participants. The participants' data were collected kept confidential.

Consent to participate

A written consent was obtained.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

None to declare

Financial disclosure: None

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Authors' contributions

ITS developed and designed the study, analyzed and interpreted the data, wrote the manuscript. SC developed the study, collected and analyzed the data, and wrote the manuscript. VSP performed statistical analysis. All authors reviewed the drafts, read, produced, and approved the final manuscript.

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