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Hepatitis B and Associated Risk Factors among Specific Populations in Lubumbashi (Democratic Republic of the Congo)

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Abstract

Background: Hepatitis B virus (HBV) infection remains a major public health issue in sub-Saharan Africa. In Lubumbashi (DRC), data on HBV transmission risk factors are limited, however some cultural practices (e.g., scarification) and specific groups (key populations, HIV co-infection) are identified and may influence the epidemiology trend of infection. **Objective:** To identify risk factors associated with HBV infection among the population of Lubumbashi. **Methodology:** An analytical cross-sectional study was conducted between March and August 2024, including 469 participants recruited from hospitals, shelters for key populations, and Kasapa Central Prison. Sociodemographic, behavioral, and biological data were collected. Statistical analysis involved bivariate tests and robust Poisson regression to identify independent predictors of HBsAg positivity. The confidence interval used was 95%. **Results:** The median age of participants was 31 years. HBV infection was more common among married people, individuals living with HIV and non-key population. However, in the multivariate analysis, only key population membership remained significantly associated, showing a protective effect against HBV infection (aPR = 0.18; 95% CI: 0.12 - 0.28; p < 0.001). **Conclusion:** Belonging to a key population (e.g., MSM, sex workers, prisoners) appeared to be a protective factor, likely due to better access to targeted prevention and awareness programs. These findings highlight the need for differentiated and context-specific strategies to combat HBV in Lubumbashi, while expanding preventive services to the general population.

Keywords

Risk Factors, Key Populations, HIV Co-Infection, Scarification, Targeted Prevention

1. Introduction

Background

Infectious diseases often display unique characteristics depending on geographic and environmental context. Hepatitis B virus (HBV) infection, in particular, spreads through distinct patterns influenced by lifestyle and local traditions.

The main documented routes of HBV transmission include body fluid exchanges (vaginal, seminal, and saliva), blood and its derivatives (e.g., through transfusions), the use of contaminated sharp instruments, unprotected sexual intercourse, and mother-to-child transmission during childbirth, lactation, or antenatally in case of intrauterine bleeding [1].

For example, in Brazil, a 10-year multicenter surveillance study revealed regional differences in HBV transmission. In southern Brazil, blood-related transmission was dominant, whereas in the north and southeast, sexual and drug injection routes were more common [2].

In northern Palestine, a 2021-2022 case-control study identified dental visits as a major risk factor for HBV transmission [3].

A meta-analysis from Benin, Nigeria, Côte d'Ivoire, and Togo estimated HBV prevalence at 5% in children aged 0 - 16 years, rising to 9% among HIV-infected children. Key risk factors included HIV co-infection, maternal HBsAg positivity, and exposure to scarification [4].

A 2011 Moroccan study highlighted sexual transmission as the primary HBV route [5]. In sub-Saharan Africa, despite regional variations, mother-to-child transmission remains the main route [1] [6].

Additional risk factors exist within specific populations. In Mozambique, among people who inject drugs, older age and syringe sharing were significantly associated with HBV-HIV co-infection [7].

Despite numerous global studies on HBV transmission, there is a notable lack of data specific to the Democratic Republic of the Congo (DRC), especially Lubumbashi. This makes it difficult to apply conclusions drawn from other regions to the local context.

Africa's cultural diversity results in varied practices across regions. Scarification, for instance, is deeply rooted in many Congolese traditions for therapeutic, aesthetic, or spiritual reasons.

In a multifactorial approach to analyzing HBV transmission, evaluating scarification alongside other factors like HIV status and key population membership is essential.

HBV infection is a major public health concern due to its high morbidity. Identifying the region- and population-specific determinants of transmission is crucial to guide effective prevention and control strategies.

The cultural and behavioral diversity across populations can obscure underlying risks and hinder targeted health policy implementation. This study aims to fill knowledge gaps by identifying HBV risk factors specific to Lubumbashi.

Objectives

General Objective: To identify factors associated with HBV infection in the Lubumbashi population.

Specific Objectives:

- To identify the major HBV transmission risk factors in Lubumbashi.
- To demonstrate that scarification is a determinant of HBV infection in Lubumbashi.
- To develop a predictive model of infection risk among HBV-positive individuals in Lubumbashi.

2. Methodology

2.1. Study Design and Period

This was an analytical cross-sectional study of HBV infection and associated risk factors conducted in Lubumbashi between March 1 and August 30, 2024.

2.2. Study Setting

Participants were recruited from the following: 1) HIV treatment centers at University Clinics of Lubumbashi, Kenya General Hospital, Katuba Hospital, Sendwe Hospital, and associated transfusion units. 2) Shelters and service centers for key populations. 3) Kasapa Central Prison.

2.3. Study Population

The target population comprised residents of Lubumbashi or inmates at Kasapa Central Prison.

2.4. Sampling and Sample Size

An exhaustive sampling approach was used, guided by a minimum sample size calculated via two-proportion comparison. With 80% power ($\beta = 0.20$) and 95% confidence level ($\alpha = 0.05$), the formula used was:

$$n = 2\left(P_1 - P_0\right)^2 \times \left(Z\alpha + Z\beta\right)^2 \big/ \left[p\left(1-p\right)\right];$$

where $p = \left(P_1 + P_0\right)/2$.

The calculation was performed using Epi Info's StatCalc tool and yielded a minimum required sample size of 460 subjects.

2.5. Case Selection

Participants were identified via voluntary or targeted HBV screening in the sites. Recruitment sources included HIV care centers, pre-transfusion screening, voluntary hospital testing, key population centers, and the prison system.

Inclusion Criteria:

- Aged ≥ 16 years
- Resident of Lubumbashi or incarcerated at the time of the study
- Provided informed consent

Exclusion Criteria:

- Unable to provide reliable history regarding HBV risk exposures
- Declined to participate

2.6. Study Variables

Sociodemographic Variables: Age (years), Sex, Marital status, Commune and neighborhood, Educational level, Economic status.

Behavioral/Exposure Variables: Monogamous or stable partner, Multiple sexual partners, History of blood transfusion (yes/no; year), Scarification (yes/no), Tattooing (yes/no), Use of sharp objects (yes/no), Drug injection (yes/no).

Subgroup Status: HIV status; Key population membership: sex workers, clients, MSM, prisoners.

Biological Variables: HBsAg detection using two rapid tests (ACCURATE and SUNNYMED), HBV DNA quantification using RotorGene-6000 and COBAS® TaqMan (Roche).

2.7. Data Analysis

Data were analyzed using Stata version 15.0 and Microsoft Excel (Office 365).

A descriptive analysis was first conducted, presenting frequencies and proportions for categorical variables, while medians and interquartile ranges (IQR) were reported for continuous variables. The Shapiro-Wilk test and histograms were used to assess the normality of the age distribution.

For the bivariate analysis, the Chi-square test or Fisher's exact test was applied to compare categorical variables, depending on expected frequencies. The Kruskal-Wallis's test was used for comparing continuous variables between groups. A 95% confidence interval was used.

The Prevalence Ratio (PR) was calculated as the ratio of the prevalence in the exposed group to that in the unexposed group.

To identify independent factors associated with the outcome, a multivariate analysis was performed using robust Poisson regression, allowing estimation of adjusted prevalence ratios (aPRs) with 95% confidence intervals.

Only variables that were statistically significant in bivariate analysis were retained in the final model.

2.8. Ethical Considerations

This study received approval from the Ethics Committee of the University of Lubumbashi (Ref: UNILU/CEM/114/2022). Written informed consent was obtained. Data confidentiality and anonymity were strictly maintained. HBV-positive individuals were referred for appropriate care following WHO 2024 guidelines [6].

3. Results

3.1. Descriptive Analysis

The study included 469 participants. Their origins are presented in **Table 1**.

Table 1. Recruitment sites of study participants.

Origin	Frequency	%
University Clinics	67	14.29
Sendwe Hospital	2	0.43
Katuba Hospital	5	1.07
Kenya Hospital	21	4.48
Kasapa Central Prison	90	19.19
Lubumbashi (urban community)	284	60.55

Most participants came from the population of Lubumbashi.

The general characteristics of the two groups are presented in **Table 2**.

Table 2. General characteristics of study participants.

Variable	Frequency	%
Biological sex		
Female	201	42.86
Male	268	57.14
Key Population	351	74.84
HIV Positive	83	17.70
Key Population		
Sex Worker	149	31.77
Other Categories		

Continued

MSM	109	23.24
Prisoner	90	19.19
Client of Sex Worker	20	4.26
Marital Status		
Single	327	69.72
Divorced	18	3.84
Married	106	22.60
Widowed	18	3.84
Living conditions		
Cohabiting	83	17.70
Community Living	90	19.19
Solitary living	296	63.11

The age of the participants was 31 years (range: 16 - 74), and the comparison between the groups is shown in **Table 3**.

Table 3. Median age comparison across groups.

Group	Median Age (years)	P-value
Female	33 (17 - 74)	0.005
Male	30 (16 - 72)	
HBV Positive	35 (19 - 72)	0.012
HBV Negative	30 (16 - 74)	
Key Population	29 (16 - 69)	0.000
Non-Key Population	38 (19 - 74)	
HIV Negative	30 (16 - 71)	0.000
HIV Positive	38 (18 - 74)	

Participants infected with HBV, those who are HIV-positive, and individuals from non-key populations had a higher median age compared to their respective counterparts.

The investigation of potential risk histories for hepatitis B virus transmission revealed a predominance of unprotected sexual practices. This is presented in **Figure 1**.

The first step to identify associated factors to HBsAg, marital status, belonging to key population and HIV infection were found. See **Table 4**.

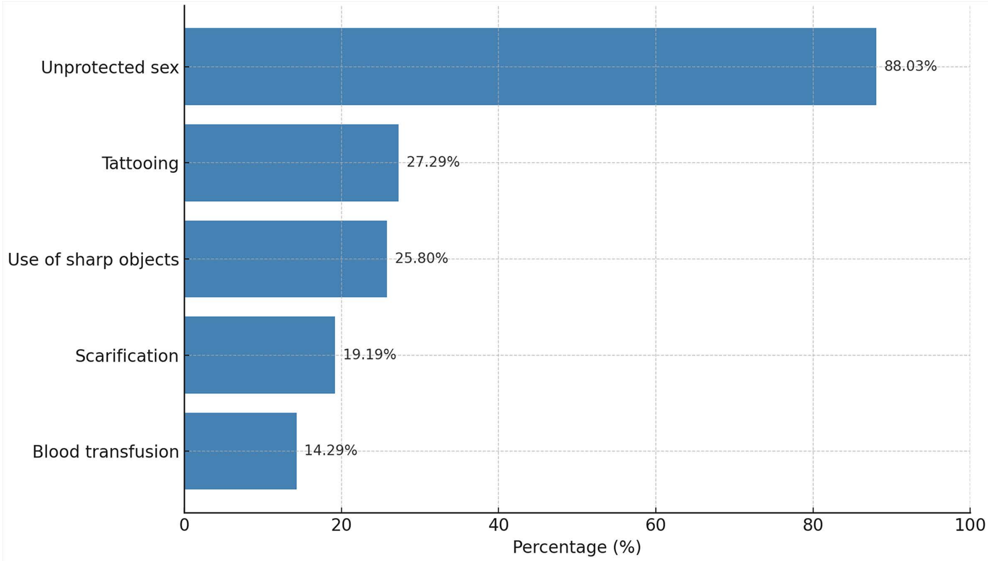

Figure 1. Proportions of participants reporting exposure to various risk factors for HBV transmission.

Table 4. Bivariate analysis of risk factors associated with HBV infection.

Risk Factor	HBsAg Positive n (%)	P-value
History of Scarification	20 (22.22%)	0.940
No Scarification	83 (21.90%)	
Use of Sharp Objects	33 (27.27%)	0.101
No Use of Sharp Objects	70 (20.11%)	
Unprotected Sexual Intercourse	58 (16.43%)	0.142
No Unprotected Sex	12 (25.00%)	
Tattooing	23 (17.97%)	0.201
No Tattooing	80 (23.46%)	
Blood Transfusion	17 (25.37%)	0.470
No Transfusion	86 (21.39%)	
HIV Positive	38 (45.78%)	0.000
HIV Negative	65 (16.84%)	
Key Population	35 (9.97%)	0.000
Non-Key Population	68 (57.63%)	
Married	41 (38.68%)	0.000002
Not Married	62 (17.08%)	

3.2. Bivariate and Multivariate Analysis

The next step, in a multivariate analysis, only key population and HIV positive status remained significative, key population as a protective factor (PR: 0.37 [0.21 - 0.63]) and HIV infection as a risk factor (PR: 2.68 [1.58 - 4.58]), this is presented in **Figure 2**.

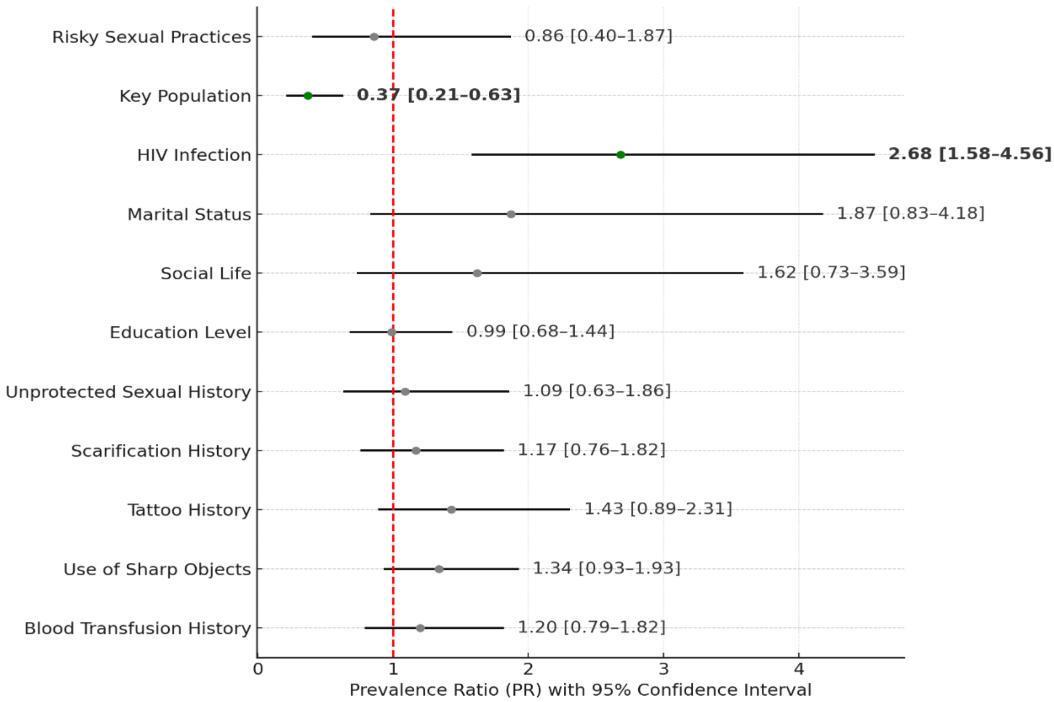

Figure 2. Factors associated with HBsAg positivity—robust Poisson regression.

The model was then tested to assess its fitness

Goodness-of-fit assessment

Goodness-of-fit chi^2 = 318.2699

Prob > chi^2 (389) = 0.9964

Probability > 0.05, indicating that the model fits the data well (no significant overdispersion).

Table 5. Adjusted model—factors independently associated with HBsAg positivity.

Variable	Adjusted Prevalence Ratio (95% Confidence Interval)	P-value	Significant?
Key Population	0.18 [0.12 - 0.28]	0.000	Yes
HIV Infection	1.17 [0.82 - 1.67]	0.396	No
Constant	0.53 [0.42 - 0.68]	0.000	–

The final adjusted model with associated factors reveals that key population is the remaining factor. Table 5 presented a PR of 0.18.

4. Discussion

The inclusion of participants was designed to cover all segments of the population potentially at risk for HBV infection. To this end, multiple sites frequently visited by key populations were targeted, including correctional facilities—settings that are rarely represented in surveys conducted in the Democratic Republic of the

Congo (DRC). Given the limited access to screening within the general population, most participants (60.6%) were recruited from this group, while 19.2% were drawn from the prison population.

Male participants predominated in the sample, with a female-to-male ratio of 43/57. This imbalance likely reflects the randomness inherent to the sampling process. Ten sites hosting key populations across various districts of Lubumbashi were investigated. Some sites exclusively served female sex workers, while others included mixed populations. In total, 109 men from key populations—mainly men who have sex with men (MSM)—and 149 female sex workers were recruited.

Most HIV-HBV co-infected individuals were identified during hospital-based screening campaigns. The overall HIV prevalence in the study population was 17.7%, which is considerably higher than the estimated prevalence in the general population—likely reflecting the specific screening context.

Regarding marital status, the sample was predominantly composed of single individuals (69.72%), which may correspond with the more liberal sexual behaviors commonly observed in key populations. Cohabitation and communal living were uncommon, whereas 63.11% of participants reported living alone.

Median age comparisons across subgroups revealed significant differences. Women had a slightly higher median age than men (33 years vs. 30 years), possibly due to delayed healthcare-seeking behavior. Participants infected with HBV were, on average, older than non-infected individuals (35 vs. 30 years), potentially indicating earlier exposure to the virus. Similarly, people living with HIV (PLHIV) exhibited a higher median age (38 years) compared to their HIV-negative counterparts (30 years), suggesting late acquisition or delayed diagnosis.

Conversely, key populations had a significantly lower median age (29 years vs. 38 years for non-key populations). This could reflect both age-specific behaviors and the impact of targeted screening programs focusing on younger, high-risk groups.

These findings emphasize the need to tailor screening and prevention strategies to the demographic and behavioral profiles of target populations. While young adults remain a critical group for preventive efforts, older individuals should not be overlooked in infectious disease control strategies. Continued and equitable access to services for key populations is essential to sustaining the apparent benefits observed in these groups. A differentiated, context-sensitive approach to care and prevention policies is therefore warranted.

4.1. Risk Factors Considered in the Study

a) Sexual identity ("Sexual practice" variable)

Sexual behavior patterns may influence the risk of sexually transmitted infections (STIs). In our cohort, a substantial proportion of participants reported engaging in male-to-male sexual contact (MSM). Unprotected MSM practices confer a risk of HBV transmission, though this risk is typically lower than that associated with opposite-sexual contact in low-prevalence settings such as the United States or Germany [1].

However, our analysis revealed no statistically significant association between reported sexual behavior and HBV infection status (PR = 0.86; 95% CI: 0.40 - 1.87). The confidence interval spanning unity indicates that no conclusive evidence exists for differential HBV risk between these groups in our study population.

b) Social life

Social isolation was associated with a non-significantly elevated prevalence ratio (PR = 1.62; 95% CI: 0.73 - 3.59). Active social engagement, particularly involving interpersonal proximity (e.g., shared needle use or unprotected sex), compounded by environmental risks like percutaneous procedures in non-sterile settings, may drive transmission in high-contact networks.

c) HIV infection

In crude analysis, HIV infection demonstrated a significant association with HBV co-infection (PR = 2.68; 95% CI: 1.58 - 4.56). However, after adjustment for key population status, this association attenuated substantially (adjusted PR = 1.17; 95% CI: 0.82 - 1.67), indicating no statistically significant relationship in the adjusted model.

Data on HBV/HIV co-infection remain limited in the Democratic Republic of the Congo (DRC). Regional studies, however, report heterogeneous prevalence: 7.9% (95% CI: 6.2 - 9.6) in Uganda (Chiesa *et al*., 2016) [8], 12.1% at Fann University Hospital, Senegal (Ramírez Mena *et al*., 2019) [9], and 12.2% in South Africa (Kaswa & de Villiers, 2023) [10]. Meta-analyses corroborate this variation, estimating sub-Saharan African co-infection prevalence among PLHIV at 7.6% [11] and 10.5% (95% CI: 9.6 - 11.3) overall, with elevated rates in West (12.8%) and Central Africa (11.2%) [12].

These findings align with the WHO 2024 recommendations for universal HBV screening among people living with HIV (PLHIV) and highlight critical implementation gaps. Although the HBV prevalence observed in our cohort might suggest limited HIV co-infection impact, the shared transmission routes and accelerated HBV progression in immunocompromised individuals necessitate sustained vigilance through systematic screening protocols.

d) Previous scarification

Traditional cutaneous scarification is recognized by the WHO as a potential vector for HBV transmission in populations which practices it analogous to ritual circumcision [13]. This enduring practice transcends socioeconomic strata and retains cultural significance. Historically valorized as an aesthetic enhancement for women, it persists through purported therapeutic applications in traditional medicine. Substantial segments of the population continue seeking such interventions in non-clinical settings. Concurrently, indigenous cosmologies frequently attribute disease etiology to supernatural forces, thereby promoting ritualistic interventions—including scarification—as healing modalities.

Our data revealed a prevalence ratio (PR) of 1.17 (95% CI: 0.76 - 1.87), indicating no significant association between scarification and HBV seropositivity. This finding contrasts with a Kenyan cohort study of 1000 adolescent blood donors, which reported an HBsAg seroprevalence of 13.2% among individuals with a history of scarification. Multivariate analysis in the Kenyan study demonstrated a significant association (adjusted OR = 5.47; 95% CI: 1.93 - 15.55) [14]. Similarly, a study in Cameroon found significantly higher odds of HBsAg positivity among individuals reporting scarification or other traditional procedures (adjusted OR = 2.87; 95% CI: 1.67 - 4.92) [15].

A key methodological difference is that the Kenyan study assessed scarification status through physical examination for scars, whereas our study relied solely on self-report. This introduces the potential for recall bias, particularly if scarification occurred in early childhood and was subsequently forgotten. Additionally, factors such as variations in the timing of scarification events between individuals or low viral load in the source blood could contribute to the observed discrepancy.

Supporting the trend observed in our data, research in KwaZulu-Natal identified scarification as a potential modifier of HBV risk. While the overall association was not significant, women exhibited a borderline association (adjusted RR = 1.37; 95% CI: 0.9 - 2.1), prompting recommendations for targeted interventions [16]. The point estimate and confidence interval from this study (RR = 1.37, CI spanning unity) align more closely with our results (PR = 1.17, CI spanning unity with wide extension after).

A study in Nigeria concluded that scarification, along with practices such as tattooing and blood transfusion, is significantly associated with HBV seropositivity.

A systematic review of studies conducted in Kenya and Uganda identified scarification as a significant independent predictor of HBV infection, alongside blood transfusion and HIV seropositivity. The estimated HBV prevalence in that region was approximately 6% [17].

Another systematic review found that sharing sharp objects, a practice often linked to scarification, is a significant HBV infection risk factor among pregnant women in Africa. The review emphasized the need for targeted prevention strategies [18].

These findings highlight the importance of raising awareness about the risks associated with these practices [19].

e) Tattooing

In our study, no significant association was found between HBV infection and modern tattooing practices (p = 0.142). Although increasingly popular, tattooing has not been structurally regulated to allow health system monitoring of blood-borne disease prevention by. Among the 469 study participants, 27.29% were tattooed—a substantial proportion. Despite this, no association with HBV infection was found in our data neither in an African systematic review (2024), on pregnant women, where no significant statistical association between tattooing and HBV infection (adjusted OR = 1.12; 95% CI: 0.77 - 1.47) was found [18].

A 2024 French nationwide cohort study (N=110402) demonstrated a substantially elevated risk of HBV transmission associated with tattooing performed in non-commercial settings (adjusted OR = 3.41; 95% CI: 2.17 - 5.36), with informal and clandestine procedures exhibiting the highest hazard profiles compared to regulated establishments [20].

A meta-analysis of 31 studies published between 1961 and March 2011 across 19 countries showed an overall association between tattooing and HBV infection (OR = 1.48; 95% CI: 1.30 - 1.68), particularly among high-risk populations (drug users, street youth, and HIV-positive individuals) [21].

A more recent meta-analysis involving 48 publications confirmed an increased risk for tattooed individuals compared to non-tattooed (OR = 1.55; 95% CI: 1.31 - 1.83) [22].

The World Health Organization (WHO) recommends safe tattooing practices, including the use of sterile, single-use equipment and proper training for tattoo artists [23].

f) Use of sharp objects

Percutaneous exposure to infected blood can be present with contaminated sharps in household (razors, scissors), commercial (barbershops, salons), or clinical settings (needles, scalpels). This transmission mode is potentiated by HBV's environmental stability—remaining infectious on surfaces for 7 days [24]. While our study assessed domestic and public exposures, it did not capture occupational injuries among healthcare workers (a recognized limitation).

Comparable studies reported considerable risks: 14.5% HBV prevalence among barbers in Ghana using non-sterile instruments [25], 28.1% seropositivity among barbers in Rabat, Morocco, and 25.1% among their clients. These findings highlight the role of barbershop shaving as a risk factor [26].

In our study, the unadjusted prevalence ratio was 1.34 [95% CI: 0.93 - 1.93]. The lower bound was close to unity, and the CI extended further above than below, suggesting a non-obvious but plausible trend to risk suggesting that a large-scale study targeting barbers and hairdressers could clarify this risk further.

Generally, reused or poorly sterilized objects are particularly incriminated, with the risk proportional to wound depth, blood volume, and donor viral load [27].

g) History of blood transfusion

The global transmission risk via transfusion is estimated at 1/500,000 to 1/1,000,000 donations. This risk has declined significantly over the years—from about 6% before 1970—due to improved transfusion safety measures [28].

WHO transfusion safety policies recommend HBsAg testing in low-resource, high-endemic countries, and additional anti-HBc antibody testing, nucleic acid amplification, and HBV DNA quantification in wealthier, low-endemic settings [28]. Consequently, residual risks of occult HBV infection remain in poorer countries, where HBV DNA may persist at undetectable levels [29].

Africa has high HBV prevalence among blood donors (average 5.53%) and residual infection prevalence of 3.18% [30].

In our study, the prevalence ratio was 1.20 [95% CI: 0.79 - 1.82], indicating no significant risk.

h) Being a key population

Key populations are groups at increased risk of infection (HIV, viral hepatitis, STIs) due to specific behaviors or circumstances, regardless of epidemic type or local context [31]. Identified key populations in our study included men who have sex with men, female sex workers, and incarcerated individuals.

Other studies report risks in these groups—for example, a 9% HBV prevalence among HIV-positive MSM (95% CI: 4 - 18) [32], driven by partial vaccination, unknown serostatus, unprotected sex, and co-infections. Incarcerated populations in Europe have HBsAg rates ranging from 0.3% (Ireland) to 25.2% (Bulgaria), depending on country and study.

Our analysis revealed a substantial protective association against HBV infection among key populations considered as a risk population (adjusted PR = 0.18; 95% CI: 0.12 - 0.28), indicating an 82% risk reduction. This robust effect is mainly explained by sex workers and incarcerated population which influenced this result. Critical consideration of potential mechanisms must be made; enhanced access to prevention through targeted interventions, or heightened risk awareness (e.g., consistent condom use among sex workers). Further mechanistic studies are warranted to elucidate these pathways.

In Lubumbashi, key populations, particularly those engaged in high-risk sexual practices, are typically organized into groups based on their geographic location. This community-based structure has enabled non-governmental organizations (NGOs) to implement targeted awareness campaigns directed at group leaders. Once trained, these leaders are responsible for disseminating prevention messages within their peer networks, thereby facilitating the flow of information among individuals who share similar behaviors. This peer-led communication model has proven effective in reinforcing preventive messages by leveraging the social proximity and trust among group members.

A second component of the prevention strategy involves the distribution of protective tools, primarily male and female condoms, as well as the provision of voluntary and confidential screening services, with a focus on HIV and other sexually transmitted infections (STIs). These services are often delivered on-site or through mobile outreach clinics, helping to overcome barriers to access and improve uptake among hard-to-reach populations.

A third intervention strategy includes the organization of community dialogue sessions, which bring together members of various key population groups and other stakeholders from their respective communities. These sessions provide opportunities for experience sharing, knowledge exchange, and mutual learning, ultimately contributing to positive behavioral change. Through this participatory approach, the intervention fosters greater awareness, empowerment, and community ownership of risk-reduction practices.

4.2. Study Limitations

This study may be subject to recall bias, particularly concerning early-life events such as scarification or other skin-piercing procedures. Data on vaccination history were excluded due to unreliable recall. Furthermore, hepatitis B vaccination was only introduced in the DRC in 2018 and thus had limited impact on our predominantly adult cohort.

Larger, more representative studies are needed to elucidate the relationship between cultural practices and HBV transmission dynamics.

5. Conclusion

Being a member of key population was found to be protective against HBV acquisition, potentially attributable to structured interventions including targeted awareness campaigns, routine screening protocols, and intensified prevention programs. While traditional scarification practices showed no significant epidemiological linkage to infection in this cohort, their investigation in larger population studies merits consideration. Sustained surveillance among people living with HIV (PLHIV) remains imperative for early detection and prompt management of HBV co-infections.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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