Hepatitis B, C, and D virus and human T-cell leukemia virus types 1 and 2 infections and correlates among men who have sex with men in Ouagadougou, Burkina Faso

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Abstract

Background: Men who have sex with men (MSM) are considered to be at significant risk for sexually transmitted infections (STI) and bloodborne viruses including viral hepatitis types B, C, and D (HBV, HCV, and HDV) and human T-cell leukemia virus types 1 and 2 (HTLV 1&2). This study aimed to assess the seroprevalence and correlates of HBV, HCV, HDV, and HTLV-1&2 antibodies among MSM in Ouagadougou, Burkina Faso.

Methods: We conducted a cross-sectional survey to assess the biological and behavioural characteristics among MSM in Ouagadougou from January to April 2013. Serum specimens obtained were tested for the presence of HBV, HCV, HDV and HTLV-1&2 infections. MSM 18 years and older were recruited using respondent driven sampling (RDS). Population estimates and 95% confidence intervals (CI) adjusted for the RDS design were calculated using RDS Analysis Tool (RDSAT) version 6.0.1 (RDS, Inc., Ithaca, NY). Bivariate and multivariate logistic regression analyses were conducted to assess correlates of these infections using Stata 14.

Results: A total of 329 MSM were tested. Prevalence was 20.4% (95% CI: 16.4–25.1) for HBV, 11.0% (95% CI: 8.0–14.8) for HCV, and 0.0% for HDV. Anti-HTLV 1&2 antibodies were found in 4.0% (95% CI: 2.3–6.8) of MSM. Factors independently associated with HBV infection were lack of condom use during the last anal sex act with a main male sexual partner and experience of condom tearing during anal sex. Presence of anti-HTLV 1&2 antibodies was associated with history of genital or anal lesions and injection drug use. None of the variables included in our study were associated with HCV.

Conclusions: This study shows that HBV, HCV and HTLV 1&2 prevalence among MSM in Burkina is high and suggests that comprehensive STI prevention and sexual health education services for this group are needed.

Keywords: HBV, HCV, HDV, HTLV 1&2, MSM, Burkina Faso, West Africa

Background

Many men who have sex with men (MSM) are at a higher risk of contracting sexually transmitted infections (STI) and bloodborne pathogens [1–4]. These infections include Hepatitis B, C, and D viruses (HBV, HCV, and HDV) [5–12] and human T-cell leukemia virus types 1 and 2 (HTLV 1&2) [13, 14]. Hepatitis viruses are responsible for 96% of the 1.34 million deaths related to cirrhosis and liver cancer [15]. HBV and HDV transmission are due to the presence of the virus in biological fluids (blood, semen, and vaginal secretions) of the infected individual [16, 17].

HCV is mainly transmitted through blood via blood transfusion in developing countries and via sharing syringes for injection drug use in developed countries [18]. However, recent studies show there is sexual transmission of HCV among MSM [19]. Studies from Europe have shown an increase in HCV incidence among MSM. In Switzerland, for example, HCV annual incidence among MSM increased from 0.23 (95% Confidence Interval [CI]:...
Burkina Faso. 1&2 antibodies among MSM, a high-risk population in correlates of hepatitis B, C and D virus and anti-HTLV MSM. This study aimed to assess the seroprevalence and B, C, and D as well as on HTLV 1&2 epidemiology among 20 million people are infected by HTLV 1&2 worldwide, people who inject drugs and MSM [14, 26]. HTLV 1&2 has been found among populations at risk such as syringes), or sexually [23–25]. High morbidity of HTLV 1&2 has been found among populations at risk such as people who inject drugs and MSM [14, 26–28]. More than 20 million people are infected by HTLV 1&2 worldwide, and West Africa is considered a highly endemic area [23].

In Sub-Saharan Africa, very few data exist on hepatitis B, C, and D as well as on HTLV 1&2 epidemiology among MSM. This study aimed to assess the seroprevalence and correlates of hepatitis B, C and D virus and anti-HTLV 1&2 antibodies among MSM, a high-risk population in Burkina Faso.

Methods
Study design
A cross-sectional survey was conducted among MSM recruited using respondent driven sampling (RDS). RDS is a peer-recruitment sampling method designed to collect rigorous, representative data from hard-to-reach populations [29–31]. In preparation for this first integrated biological and behavioral survey, formative pre-survey research was conducted using formal meetings with MSM, local organizations, and government officials to explore MSM's willingness to recruit their peers, challenges in finding diverse segments of this hidden population, and preferences expressed by MSM for all study procedures. The results of these meetings suggested that RDS should be used for the survey.

Setting
The survey took place in Ouagadougou, the capital of Burkina Faso, a West African country with limited resources and high burden of viral hepatitis B and C.

Study population and recruitment
MSM were eligible to participate if they meet the following criteria: (i) at least 18 years old, (ii) assigned male gender at birth, (iii) reported anal sex with a man at least once in the past 12 months, (iv) able to provide informed consent in French, Mòoré, or Dioula, (v) had a valid coupon, (vi) lived in Ouagadougou for at least the past three months, and (vii) agreed to complete a behavioral questionnaire and human immunodeficiency virus (HIV) testing.

Recruitment chains were initiated by MSM seeds. Six MSM seeds were purposely selected. Seeds were chosen who met the study eligibility criteria, represented diverse demographics (age, education, marital status, language, and HIV status), and who were willing to promote the study.

After giving informed consent, seeds were required to complete a questionnaire and have their blood drawn. These seeds were each provided with three coded coupons which were valid for four weeks to recruit MSM peers from their social network. Individuals who were recruited by seeds and enrolled in the study were then provided with three coded coupons for further recruitment of peers. This process continued until the target sample size was reached.

Participants received male condoms, condom-compatible lubricants, HIV education materials, and information regarding existing services. They also received 2000 XOF (~$4 United States dollars [USD]) for their time and transportation costs for each study visit. Per successfully eligible peer recruited to be part of the study (for up to three peers), recruiter had received 1500 XOF (~$3 USD). To avoid individuals participating multiple times, a single study office was used in addition to the use of a unique identification code. Study staff included a site manager, a coupon manager, two data collectors, an HIV and STI test counselor, and a lab technician. All staff were trained in the study procedures to avoid duplicate enrollments.

Sample size
Sample size was previously estimated from an HIV behavior and seroprevalence study. The recruitment framework entailed 350 MSM. This size calculation was based on the assumption that populations who always use condoms have a 75% lower HIV prevalence than populations who do not, and the effectiveness of condoms is roughly 80%, with 73% used as a conservative estimate [32]. Overall, HIV prevalence was estimated at 15% with 19% prevalence among those who did not consistently use condoms. A design effect of 1.5 associated with RDS, significance level of 0.05, and a power of 80% was used.

Data collection
Data were collected from January to April 2013 in Ouagadougou. Following informed consent, MSM participants completed interviewer-administered face-to-face questionnaires in a private room. Information included sociodemographic characteristics of participants, partnerships and sexual behaviors (with men and women), condom use, knowledge, attitudes and practices related to STI, and injection drug use.

Samples collection and laboratory methods for testing
A trained nurse and lab technician respectively conducted HIV/STI counseling, venous blood specimen collection and HIV and syphilis testing in the study office. Serum
samples were stored at −20 °C and transported to the laboratory for hepatitis B, C, D and HTLV testing using DiaPro Enzyme Linked Immunoassay (ELISA) methods (https://www.diapro.it/). All tests were performed according to the manufacturer’s instructions.

HBV testing
The ELISA test kit HBsAg One version ULTRA (ULTRA-Dia.Pro, Diagnostic BioProbes Srl, Italy), able to detect HBV “s” mutant was used for hepatitis B surface antigen detection. This test uses a mix of mouse monoclonal antibodies specific to determinants “a”, “d”, and “y” of HBsAg fixed to the surface of microwells. For test procedure, 150 μl of serum were added to the microwell together with 100 μl of a second mix of mouse monoclonal antibodies, conjugated with Horseradish Peroxidase (HRP) and directed against a different epitope of the determinant “a” and against “preS”. The specific immunocomplex, formed in the presence of HBsAg in the sample, is captured by the solid phase. At the end of the one-step incubation for 120 min at 37 °C, microwells were washed to remove unbound serum proteins and HRP conjugate. Then 200 μl of chromogen/substrate (tetra-methyl-benzidine and hydrogen peroxide, TMB/H2O2 mix) were added and incubate for 30 min at room temperature. In the presence of captured HBsAg immunocomplex, the colorless substrate is hydrolyzed by the bound HRP conjugate to a colored end-product. After blocking the enzymatic reaction by adding 100 μl of sulfuric acid, its optical density was measured with the ELISA reader (Reader 270, Microelisa system, Biomerieux, France) using 450 nm filter for raiding and a 620 nm filter for background subtraction. The concentration of the bound enzyme on the solid phase becomes inversely proportional to the amount of HBsAg present in the sample.

HCV testing
For anti-HCV antibodies, the fourth generation ELISA HCV Ab-Dia.Pro test (Diagnostics BioProbes Srl, Italy) was used. This test kit uses microplates coated with HCV-specific antigens derived from “core” and “n” regions encoding for conservative and immunodominant antigenic determinants (core peptide, recombinant NS3, NS4 and NS5 peptides). The solid phase was first treated with the diluted sample (200 μl diluent + 10 μl sample) and incubated at 37 °C, 45 min. HCV antibodies were captured, if present, by the antigens. After washing out all the other components of the sample, in the second incubation (45 min, 37 °C) bound HCV antibodies, immunoglobin G and M as well, were detected by addition of 100ul of polyclonal specific and hIgG&M antibodies, labelled with peroxidase (HRP). The enzyme captured with on the solid phase, acting on the chromogen/substrate mixture (100ul of TMB/H2O2), generates an optical signal that was proportional to the amount of anti HCV antibodies present in the sample. After incubation at lab temperature (25 °C) for 15 min, 100 μl of sulfuric acid were added into each well to stop the enzymatic reaction. The optical density was measured with the ELISA reader using 450 nm filter for raiding and a 620 nm filter for background subtraction. A cut-off value let densities was interpreted into HCV antibodies negative and positive results.

HDV testing
HBsAg reactive samples were subsequently tested for detection of anti-HDV antibodies using HDV Ab Dia.Pro, Diagnostic BioProbes Srl, Italy test kit, a competitive ELISA methods. The antibodies present in the serum compete with a virus-specific polyclonal IgG, labelled with peroxidase (HRP), for a fixed amount of rec-HDV coated on the microplate. The test was carried out with two steps incubation competitive system. First the 100 ul of sample were added to the plate and specific anti-HDV antibodies bind to the adsorbed antigen and incubated for 60 min at 37 °C. After washing (4–5 cycles), 100 μl of an enzyme conjugate antibody to HDV were added and binds to the free portion of antigen coated, following by second incubation for 60 min at 37 °C. After washing, 100 μl of chromogen/substrate mixture (TMB/H2O2 mix) was dispensed and incubated for 20 min at lab temperature (25°). The concentration of the bound enzyme on the solid phase becomes inversely proportional to the amount of anti-HDV antibodies in the sample and its activity was detected by the added chromogen/substrate. After blocking the enzymatic reaction by addition of 100 μl of sulfuric acid, the optical density was measured with the ELISA reader using a 450 nm filter for raiding and a 620 nm filter for background subtraction. The concentration of of HDV-specific antibodies in the sample is determined by means of a cut-off value that allowed for the semi-quantitative detection of anti-HDV antibodies.

HTLV 1&2 testing
Anti-HTLV 1&2 antibodies were tested using the ELISA HTLV 1&2 Ab-Dia.Pro ULTRA version (Diagnostic BioProbes Srl, Italy). This test uses microplates coated with HTLV1&2 specific synthetic immunodominant antigens derived from gp46–I, gp46-II and gp21-I. The solid phase was first treated with the sample (100 μl) and anti-HTLV 1&2 antibodies are captured during incubation (for 45 min at 37 °C) by the antigens coated on the microplate. After washing out all the other components of the sample, in the second incubation for 45 min at 37 °C, bound anti-HTLV 1&2 total antibodies was detected by the addition 100 μl of specific synthetic antigens derived from gp46–I, gp46-II and gp21, labelled with peroxidase (HRP). The enzyme captured on the solid phase, acting on the chromogen/substrate mixture, generates an optical
signal that is proportional to the amount of anti HTLV 1&2 antibodies present in the sample. After blocking the enzymatic reaction, its optical density was measured by the ELISA reader (OD 450 nm).

For each testing, manufacturer negative and positive controls, and calibrator were used. The results were calculated by the means of a cut-off value (Co) determined on the mean optic density (OD) 450 nm value of the negative control as recommended in the kit manufacturer procedure. The test results were interpreted as positive when a ratio of the samples optic density at 450 nm (S) and the cut-of-value (Co) was superior to 1.1. Assay procedure was repeated for sample with equivocal result (S/Co = 0.9 to 1.1). All repeated testing provided negative or positive result and have been considered.

### Data processing

Data were entered using EpiData 3.1 (The EpiData Association, Odense, Denmark) and exported into Stata 14 (StataCorp, College Station, TX) for analysis.

Descriptive statistics were used to describe participants’ characteristics, HBV, HCV, HDV and HTLV 1&2 seroprevalence, and sexual behaviors. All proportions were adjusted to account for the RDS method. This adjustment takes into consideration the probability of each participant to be included in the study. This probability was measured through weighting based on the size of each participant’s network. Network size was determined using the survey question: “How many different people do you know personally who are MSM? i.e., you know them and they know you, you have seen them in the last 2 years, and you could contact them if you needed to?” The mean network size of study participants was 17 (minimum = 1 and maximum = 600). Population estimates and 95% CI adjusted for the RDS design were produced using the RDS Analysis Tool (RDSAT) version 6.0.1 (RDS, Inc., Ithaca, NY).

Bivariate and multivariate logistic regression analyses were conducted to assess factors associated with testing positive for each of the infections (HBV, HCV, HDV, and HTLV 1&2). Variables significantly associated with the infection at the p < 0.20 level were included in the multivariate models.

### Ethical considerations and protection of the participants

The study received ethical approval from the Ethics Committee for Health Research (CERS) of Burkina Faso. The study was implemented in a secure setting, and questionnaires were conducted in a private office. Collection of blood samples was performed by a trained staff member. Research ethic and sensitivity training were provided to all study staff before study implementation. Confidentiality was maintained by using a unique study identifier rather than real names on questionnaires and all study materials, protecting all electronic data with passwords, and storing hard copies of data in locked cabinets. Participant unique and anonymized codes were used to link study questionnaires with blood samples. All participants who tested positive for HIV were referred to a healthcare center.

### Results

A total of 329 sera of MSM including original seeds were tested for hepatitis B, C, and D virus and HTLV 1&2 infections.

#### Socio-demographic characteristics

Participants’ socio-demographic characteristics are presented in Table 1. The mean age was 22.9 ± 4.0 years. In terms of sexual orientation, 71.9% (95% CI: 66.7–76.5) of MSM reported being gay/homosexual. Less than half of the study participants were bisexual (44.1%; 95% CI: 38.9–48.9). A minority (2.1, 95% CI: 0.0–4.4) were transgender. The majority of study participants were single (94.6, 95% CI: 91.6–96.5). Most of them were born in Burkina Faso. Over 70% (71.8, 95% CI: 66.8–76.4) of the participants recruited were students or pupils, while employees represented 21.6% (95% CI: 17.3–26.3).

#### HBV, HCV, HDV and HTLV 1&2 seroprevalence

Tables 2 and 3 present the seroprevalence and factors associated with HBV, HCV and HTLV 1&2 in the bivariate and multivariate analyses.

#### Factors associated with HBV

The prevalence of HBV among MSM was estimated at 20.4% (95% CI: 16.4–25.1). Bivariate analyses showed that the factors associated with HBV infection were reporting multiple sexual partnerships with at least two male partners and a female sexual partner (p = 0.010), experiencing condom tearing during anal sex (p = 0.035), not using a condom at last anal sex with a main male sexual partner (p = 0.029), and being divorced, widowed, married or cohabiting with a woman (p = 0.023). Multivariate analysis showed that only not using a condom at last anal sex with a main male sexual partner (p = 0.033) and experiencing condom tearing during anal sex (p = 0.012) were independently associated with HBV infection (Table 3).

#### Seroprevalence of HCV

The prevalence of HCV among MSM is estimated at 11.0% (95% CI: 8.0–14.8). Although patterns of disparity were observed according to some characteristics of MSM, bivariate and multivariate analyses with study variables did not reveal any factors associated with HCV infection among MSM (Table 3).
| Variables                               | n   | RDS\textsuperscript{a}-unadjusted % | RDS-adjusted % (95% CI)   |
|-----------------------------------------|-----|-------------------------------------|--------------------------|
| Current age (years)                     |     |                                     |                          |
| 18–19                                   | 78  | 23.7                                | 23.6 (19.3–28.6)         |
| 20–24                                   | 196 | 59.6                                | 60.1 (54.7–65.3)         |
| 25–29                                   | 35  | 10.6                                | 10.6 (7.7–14.5)          |
| ≥30                                     | 20  | 6.1                                 | 5.6 (3.6–08.7)           |
| Total                                   | 329 |                                     |                          |
| Country of birth                        |     |                                     |                          |
| Burkina Faso                            | 272 | 82.7                                | 82.7 (78.2–86.4)         |
| Other countries                         | 57  | 17.3                                | 17.3 (13.6–21.8)         |
| Total                                   | 329 |                                     |                          |
| Childhood environment                   |     |                                     |                          |
| Urban                                   | 288 | 91.4                                | 91.4 (87.8–94.1)         |
| Rural                                   | 27  | 8.6                                 | 8.6 (5.9–12.2)           |
| Total                                   | 315 | 100.0                               |                          |
| Highest educational level               |     |                                     |                          |
| None or primary                         | 25  | 7.6                                 | 7.6 (5.1–11.0)           |
| Secondary                               | 239 | 72.6                                | 72.8 (67.7–77.4)         |
| University                              | 65  | 19.8                                | 19.6 (15.7–24.3)         |
| Total                                   | 329 | 100.0                               |                          |
| Occupation                              |     |                                     |                          |
| Student/pupil                           | 236 | 71.7                                | 72.0 (66.9–76.6)         |
| Employed                                | 72  | 21.9                                | 2.15 (17.4–26.3)         |
| Unemployed                              | 21  | 6.4                                 | 6.5 (4.2–9.7)            |
| Total                                   | 329 | 100.0                               |                          |
| Marital status (with a woman)           |     |                                     |                          |
| Single                                  | 310 | 94.2                                | 94.5 (91.5–96.5)         |
| Other\textsuperscript{c}                | 19  | 5.8                                 | 5.5 (3.5–8.5)            |
| Total                                   | 329 | 100.0                               |                          |
| Number of biological children           |     |                                     |                          |
| 0                                       | 305 | 92.7                                | 93.0 (89.7–95.3)         |
| ≥1                                      | 24  | 7.3                                 | 7.0 (4.7–10.3)           |
| Total                                   | 329 | 100.0                               |                          |
| Sexual orientation                      |     |                                     |                          |
| Gay/homosexual                          | 236 | 71.7                                | 71.9 (66.7–76.5)         |
| Bisexual                                | 21  | 6.4                                 | 6.5 (4.4–9.7)            |
| Heterosexual                            | 72  | 21.9                                | 21.6 (17.5–26.5)         |
| Total                                   | 329 | 100.0                               |                          |
| Anal sex position                       |     |                                     |                          |
| Receptive                               | 19  | 5.8                                 | 5.7 (3.7–8.8)            |
| Insertive                               | 310 | 94.2                                | 94.3 (91.2–96.3)         |
| Total                                   | 329 | 100.0                               |                          |
| Number of male anal sex partners        |     |                                     |                          |
| 1                                       | 75  | 22.9                                | 22.9 (18.6–27.8)         |
| 2                                       | 131 | 39.9                                | 40.1 (34.9–45.5)         |
Seroprevalence of HDV

Anti-HDV antibody testing was performed on HBV-positive samples. No participants tested positive for anti-HDV antibodies, meaning that the seroprevalence was 0.0%.

Seroprevalence and correlates of anti-HTLV 1&2 antibodies

The results show that the seroprevalence of the HTLV virus in the MSM surveyed is estimated at 4.0% (95% CI: 2.3–6.8). In the bivariate analysis, the factors associated with HTLV 1&2 infection were a history of STI symptoms (genital lesions) during the last 12 months ($p = 0.001$), not using a condom at last anal sex with a main male sexual partner ($p = 0.017$), and not using a condom at last anal sex with a casual male sexual partner ($p = 0.018$). Only the history of genital lesions (penis or anus) during the last 12 months and injection drug use were independently associated with the seroprevalence of anti-HTLV 1&2 antibodies in the multivariate analysis (Table 3).

Discussion

To our knowledge, this study is the first in West Africa to report the seroprevalence of hepatitis B, C, and D and anti-HTLV 1&2 antibodies among MSM. It shows that the seroprevalence of HBV and HCV were very high and that of anti-HTLV 1&2 antibodies was relatively high.

HBV

The prevalence of HBV (20.4%) in our sample of MSM is higher than those reported among other populations in Burkina Faso. In a recent systematic review in Burkina Faso covering the period from 1996 to 2017, the authors estimated the prevalence of HBV at 9.41% among the general population, 11.11% among pregnant women, 11.73% among blood donors and 12.6% among people living with HIV [33]. Our results suggest that MSM are a vulnerable group for HBV infection. Modes of transmission other than vertical transmission may explain the high prevalence of HBV among MSM [7, 11, 12]. In this study, the factors associated with HBV infection in the bivariate analysis were for the most part, factors related to sexual behavior, including multiple sexual partnerships with male and female partners, in addition to age $\geq$ 30 years and marital status with a woman. Older age had already been identified in some studies as associated with HBV infection [6, 7, 34], and could be explained by the accumulation of risk of exposure over time and vaccination against HBV coverage, which is increasing among younger individuals. Vaccination against HBV was only introduced in Burkina Faso in 2006 for infants [33]. The majority of MSM in our study identified themselves as gay, but over 44% reported being bisexual and have sex with men and women, and some are in a conjugal relationship with women. Bisexual MSM could have a higher risk of transmitting and acquiring STI [35], which could explain the higher prevalence of HBV infection among married MSM.

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**Table 1** Characteristics of men who have sex with men study participants in Ouagadougou (Continued)

| Variables                     | n   | RDS$^a$-unadjusted % | RDS-adjusted % (95% CI$^b$) |
|-------------------------------|-----|----------------------|-------------------------------|
| $\geq$3                       | 122 | 37.2                 | 37.0 (31.9–42.4)             |
| Total                         | 328 |                      |                              |
| Past 12 month STI$^c$ symptoms|     |                      |                              |
| No                            | 242 | 73.3                 | 73.6 (68.6–78.1)             |
| Yes                           | 87  | 26.4                 | 26.1 (21.6–31.1)             |
| Don’t know                    | 1   | 0.3                  | 0.3 (0.0–2.2)                |
| Total                         | 329 | 100.0                |                              |
| HIV$^d$ status                |     |                      |                              |
| Negative                      | 319 | 97.0                 | 98.2 (96.7–99.0)             |
| Positive                      | 10  | 3.0                  | 1.8 (1.0–3.3)                |
| Total                         | 329 |                      |                              |
| Ever injected drugs           |     |                      |                              |
| No                            | 323 | 98.2                 | 98.2 (96.0–99.2)             |
| Yes                           | 6   | 1.8                  | 1.8 (0.8–4.0)                |
| Total                         | 329 |                      |                              |

$^a$RDS Respondent driven sampling
$^b$CI Confidence interval
$^c$Married or cohabiting, divorced, separated
$^d$STI Sexually transmitted infection
$^e$HIV Human immunodeficiency virus
| Variables                              | n   | HBV Positive | RDS-adjusted HBV Positive (95% CI) | HCV Positive | RDS-adjusted HCV Positive (95% CI) | HTLV1&2 Positive | RDS-adjusted HTLV1&2 Positive (95% CI) |
|----------------------------------------|-----|--------------|-----------------------------------|--------------|-----------------------------------|-----------------|--------------------------------------|
| **Current age (years)**                |     |              |                                   |              |                                   |                 |                                      |
| 18–19                                  | 78  | 17.9         | 17.7 (10.7–27.8)                  | 7.7          | 7.3 (3.2–15.5)                    | 3.8             | 3.9 (1.3–11.5)                       |
| 20–24                                  | 196 | 19.9         | 19.6 (14.6–25.7)                  | 13.3         | 13.3 (9.2–18.9)                   | 4.1             | 4.1 (2.1–8.0)                       |
| 25–29                                  | 35  | 22.9         | 23.1 (12.9–40.0)                  | 2.9          | 0.29 (0.4–18.0)                   | 0.0             | –                                    |
| >=30                                   | 20  | 35.0         | 35.9 (18.0–58.9)                  | 15.6         | 16.4 (5.4–40.3)                   | 10.0            | 10.9 (2.7–34.8)                     |
| Total                                  | 329 | 20.7         | 20.4 (16.4–25.1)                  | 10.9         | 11.0 (8.0–14.8)                   | 4.0             | 4.0 (2.3–6.8)                       |
| **Country of birth**                   |     |              |                                   |              |                                   |                 |                                      |
| Burkina Faso                          | 272 | 21.0         | 20.7 (16.3–25.9)                  | 9.9          | 0.99 (6.9–14.1)                   | 4.0             | 4.1 (2.3–7.3)                       |
| Other countries                        | 57  | 19.3         | 18.8 (10.7–31.1)                  | 15.8         | 16.0 (8.5–28.1)                   | 3.5             | 3.6 (0.9–13.2)                      |
| **Childhood environment**              |     |              |                                   |              |                                   |                 |                                      |
| Urban                                 | 288 | 20.3         | 20.0 (15.8–25.0)                  | 10.8         | 10.8 (7.6–14.9)                   | 4.2             | 4.2 (2.4–7.3)                       |
| Rural                                 | 27  | 33.3         | 32.3 (17.5–51.7)                  | 14.8         | 15.1 (5.7–34.0)                   | 3.7             | 3.8 (0.5–22.6)                      |
| **Highest educational level**         |     |              |                                   |              |                                   |                 |                                      |
| None or primary                       | 25  | 24.0         | 24.4 (11.4–44.9)                  | 4.0          | 4.1 (0.6–24.1)                    | 4.0             | 4.1 (0.6–24.1)                      |
| Secondary                             | 239 | 16.5         | 16.2 (12.0–21.4)                  | 11.7         | 11.7 (8.1–16.4)                   | 4.2             | 4.2 (2.3–7.7)                       |
| University                            | 65  | 34.8         | 34.5 (23.9–46.7)                  | 10.8         | 11.0 (5.3–21.4)                   | 3.1             | 3.1 (0.8–11.8)                      |
| **Occupation**                        |     |              |                                   |              |                                   |                 |                                      |
| Student/pupil                         | 236 | 18.1         | 17.9 (13.5–23.3)                  | 12.3         | 12.2 (8.6–17.1)                   | 3.8             | 3.8 (2.0–7.3)                       |
| Employed                              | 72  | 28.8         | 28.4 (19.2–39.9)                  | 5.6          | 5.7 (2.2–14.3)                    | 2.8             | 2.9 (0.7–10.8)                      |
| Unemployed                            | 21  | 22.7         | 21.2 (8.9–42.6)                   | 14.3         | 14.3 (4.7–36.3)                   | 9.5             | 9.5 (2.4–31.3)                      |
| **Marital status (with a woman)**     |     |              |                                   |              |                                   |                 |                                      |
| Single                                | 310 | 19.4         | 19.1 (15.1–23.9)                  | 11.0         | 10.9 (7.9–15.0)                   | 3.9             | 3.9 (2.2–6.8)                       |
| Otherg                                | 18  | 42.1         | 42.7 (22.8–65.3)                  | 10.5         | 11.3 (2.8–35.7)                   | 5.3             | 5.6 (0.8–31.2)                      |
| **Number of biological children**     |     |              |                                   |              |                                   |                 |                                      |
| 0                                     | 305 | 20.8         | 20.5 (16.3–25.3)                  | 10.5         | 10.5 (7.5–14.4)                   | 3.9             | 4.0 (2.3–6.9)                       |
| >=1                                   | 24  | 20.8         | 20.1 (8.4–40.8)                   | 16.7         | 17.6 (6.8–38.6)                   | 4.2             | 4.4 (0.6–25.6)                      |
| **Sexual orientation**                |     |              |                                   |              |                                   |                 |                                      |
| Gay/homosexual                        | 236 | 20.3         | 20.1 (15.5–25.7)                  | 10.2         | 10.3 (7.0–14.9)                   | 3.0             | 3.0 (1.4–6.2)                       |
| Bisexual                              | 21  | 31.8         | 30.5 (15.0–52.1)                  | 19.0         | 19.0 (7.3–41.3)                   | 4.8             | 4.8 (0.7–27.4)                      |
| Heterosexual                          | 72  | 19.2         | 18.4 (11.1–29.0)                  | 11.1         | 10.8 (5.4–20.3)                   | 6.9             | 7.1 (3.0–16.0)                      |
| **Anal sex position**                 |     |              |                                   |              |                                   |                 |                                      |
| Receptive                             | 19  | 26.3         | 26.9 (11.6–50.7)                  | 10.5         | 10.8 (2.7–34.5)                   | 0.0             | 0.0                                  |
| Insertive                             | 310 | 20.5         | 20.1 (16.0–24.9)                  | 11.0         | 11.0 (7.9–15.0)                   | 5.0             | 5.0 (2.8–8.9)                       |
| **Tested for STI in the last 12 months** |     |              |                                   |              |                                   |                 |                                      |
| No                                    | 241 | 18.7         | 18.5 (14.1–24.0)                  | 12.0         | 12.0 (8.4–16.8)                   | 3.8             | 3.4 (1.7–6.6)                       |
| Yes                                   | 85  | 27.6         | 26.8 (18.5–37.1)                  | 8.2          | 8.4 (4.0–16.6)                    | 4.7             | 4.8 (1.8–12.2)                      |
| **Past 12 month STI symptoms**        |     |              |                                   |              |                                   |                 |                                      |
| No                                    | 311 | 19.6         | 19.4 (15.4–24.3)                  | 11.3         | 11.3 (8.2–15.3)                   | 2.9             | 2.9 (1.5–5.6)                       |
| Yes                                   | 18  | 38.9         | 37.4 (18.6–61.0)                  | 5.6          | 5.7 (0.8–31.4)                    | 22.2            | 22.8 (8.8–47.4)                     |
| **Vaccinated against HBV**            |     |              |                                   |              |                                   |                 |                                      |
| No                                    | 264 | 22.7         | 22.4 (17.8–27.9)                  | 10.2         | 10.2 (7.1–14.5)                   | 3.0             | 3.1 (1.5–6.0)                       |
Multivariate analysis in our study showed that only condom use at last anal sex with a main male sexual partner ($p = 0.033$) and condom tearing during anal sex ($p = 0.012$) were independently associated with HBV infection, suggesting transmission of the virus through high-risk sex.

**HDV**

In our study, no HBsAg-bearing MSM was infected with HDV. A prior study found a 0.1% (95% CI: 0.06–0.23) HDV prevalence among men in general population of Burkina Faso [36]. The very low prevalence in our study could be explained by the small size of the sample. However, although the number of positive HBsAg samples analyzed in our study is low, zero seroprevalence of anti-HDV antibodies has also previously been reported by studies in Sub-Saharan Africa. An analysis of 49 pregnant women with HBsAg in Burkina Faso revealed no evidence of anti-HDV antibodies [37]. Similarly, in Mozambique, Cunha et al., in their study of 146 blood donors infected with HBV, found no positive cases of anti-HDV antibodies [38].

**HCV**

West Africa is considered an area with a high prevalence of HCV [39, 40]. We found in our study a prevalence of 11% in MSM. This prevalence is three times higher than that reported in Burkina Faso, and in West Africa in
| Variables                               | n   | HBV infection | HCV infection | HTLV1&2 infection |
|-----------------------------------------|-----|---------------|---------------|------------------|
|                                         |     | Positive OR (95% CI) | p   | AOR (95% CI) | p   | Positive OR (95% CI) | p   | AOR (95% CI) | p   |
| Current age (years)                     |     |               |               |                  |
| 18–20                                   | 78  | 17.7          | 1             |                  |
| 20–24                                   | 196 | 19.6          | 1.13 (0.57–2.23) | 0.724         | 13.3 | 19.6 (0.76–5.04) | 0.162 | 2.07 (0.80–5.33) | 0.131 | 4.1 | 1.05 (0.27–4.10) | 0.943 |
| 25–29                                   | 35  | 23.1          | 1.14 (0.52–2.75) | 0.502         | 0.29 | 0.37 (0.04–3.33) | 0.381 | –       | –       | 0.0 | 1             |                  |
| >= 30                                   | 20  | 35.9          | 2.60 (0.86–7.87) | 0.089 | 0.76 (0.11–4.94) | 0.774 | 164 | 2.50 (0.55–11.20) | 0.230 | –   | 10.9 | 3.01 (0.46–19.65) | 0.248 |
| Total                                   | 329 | 20.4          | 11.0          | 4.0             |
| Country of birth                        |     |               |               |                  |
| Burkina Faso                            | 272 | 20.7          | 1             |                  |
| Other countries                         | 57  | 18.8          | 0.88 (0.42–1.83) | 0.742         | 160 | 1.73 (0.76–3.94) | 0.186 | 1.88 (0.78–4.50) | 0.153 | 36  | 0.86 (0.18–4.04) | 0.853 |
| Childhood environment                   |     |               |               |                  |
| Urban                                   | 288 | 20.0          | 1             |                  |
| Rural                                   | 27  | 32.3          | 1.91 (0.80–4.51) | 0.140 | 1.46 (0.53–3.98) | 0.452 | 15.1 | 1.46 (0.47–4.55) | 0.504 | –   | 38  | 0.88 (0.11–7.17) | 0.910 |
| Highest educational level               |     |               |               |                  |
| None or primary                         | 25  | 24.4          | 1             |                  |
| Secondary                               | 239 | 16.2          | 0.60 (0.22–1.62) | 0.319         | 11.7 | 3.11 (0.40–24.17) | 0.277 | –       | –       | 4.2 | 1.04 (0.13–8.58) | 0.970 |
| University                              | 65  | 34.5          | 1.58 (0.54–4.57) | 0.393         | 110  | 2.90 (0.33–25.23) | 0.332 | –       | –       | 3.1 | 0.76 (0.06–8.93) | 0.830 |
| Occupation                              |     |               |               |                  |
| Student/pupil                           | 236 | 179           | 1             |                  |
| Employed                                | 72  | 28.4          | 1.84 (0.10–3.40) | 0.051 | 1.64 (0.60–4.47) | 0.331 | 0.57 | 0.43 (0.14–1.29) | 0.134 | 0.22 (0.03–1.38) | 0.109 | 29  | 0.73 (0.15–3.51) | 0.700 |
| Unemployed                              | 21  | 212           | 1.07 (0.36–3.36) | 0.097         | 143  | 1.19 (0.32–4.34) | 0.784 | 95  | 0.52 (0.02–13.16) | 0.238 | –   | –   |                  |
| Marital status                          |     |               |               |                  |
| Single                                  | 310 | 19.1          | 1             |                  |
| Other*                                  | 18  | 420           | 3.03 (1.16–7.86) | 0.023 | 1.44 (0.30–6.80) | 0.640 | 113 | 1.03 (0.22–4.72) | 0.964 | –   | 56  | 1.79 (0.21–14.88) | 0.589 |
| Number of biological children           |     |               |               |                  |
| 0                                      | 305 | 205           | 1             |                  |
| >= 1                                    | 24  | 201           | 0.98 (0.98–2.78) | 0.972         | 176 | 1.82 (0.58–5.73) | 0.299 | –       | –       | 44  | 1.11 (0.14–9.04) | 0.921 |
| Sexual orientation                      |     |               |               |                  |
| Gay/homosexual                          | 236 | 20.1          | 1             |                  |
| Bisexual                                | 21  | 305           | 1.58 (0.57–4.31) | 0.370         | 190 | 2.05 (0.63–6.64) | 0.229 | –       | –       | 48  | 1.62 (0.18–13.96) | 0.661 |
| Transgender                             | 72  | 18.4          | 0.90 (0.46–1.78) | 0.782         | 108  | 1.05 (0.44–2.48) | 0.904 | –       | –       | 7.1 | 2.47 (0.75–8.11) | 0.133 |
| Anal sex position                       |     |               |               |                  |
| Receptive                               | 19  | 269           | 1             |                  |

Table 3 RDS²-adjusted prevalence and bivariate and multivariate logistic regression analyses of factors associated with HBV, HCV and HTLV1&2 infection among men who have sex with men in Ouagadougou.
Table 3 RDS-adjusted prevalence and bivariate and multivariate logistic regression analyses of factors associated with HBV, HCV, and HTLV infection among men who have sex with men in Ouagadougou (Continued)

| Variables                              | n  | HBV infection | HCV infection | HTLV1&2 infection |
|----------------------------------------|----|---------------|---------------|-------------------|
| Positive OR (95% CI)                   |    | Positive OR (95% CI) | Positive OR (95% CI) | Positive OR (95% CI) |
| Positive AOR (95% CI)                  |    | Positive AOR (95% CI) | Positive AOR (95% CI) | Positive AOR (95% CI) |
| **Variables**                          |    | **HBV infection** | **HCV infection** | **HTLV1&2 infection** |
| Positive OR (95% CI)                   |    | Positive OR (95% CI) | Positive OR (95% CI) | Positive OR (95% CI) |
| Positive AOR (95% CI)                  |    | Positive AOR (95% CI) | Positive AOR (95% CI) | Positive AOR (95% CI) |
| **Insertive**                          |    |                |                |                   |
| Past 12 month STI symptoms             |    |                |                |                   |
| No                                     | 311| 19.4           | 2.47 (0.91–6.73) | 0.001             |
| Yes                                    | 18 | 37.4           | 2.47 (0.91–6.73) | 0.001             |
| Vaccinated against HBV                 |    |                |                |                   |
| No                                     | 264| 19.8           | 1              |                   |
| Yes                                    | 51 | 21.5           | 2.29 (1.22–4.30) | 0.001             |
| Type of sexual partners in the last 12 months |    |                |                |                   |
| Only males                             | 201| 19.8           | 1              |                   |
| Males and females                      | 127| 21.5           | 2.29 (1.22–4.30) | 0.001             |
| Ever experienced condom tearing during anal sex |    |                |                |                   |
| No                                     | 218| 17.4           | 1              |                   |
| Yes                                    | 106| 27.8           | 1.81 (1.04–3.16) | 0.001             |
| Condom use at last anal sex with a regular male partner |    |                |                |                   |
| No                                     | 54 | 17.9           | 1              |                   |
| Yes                                    | 240| 21.5           | 2.09 (0.92–0.92) | 0.001             |
| Condom use at last anal sex with a casual male partner |    |                |                |                   |
| No                                     | 34 | 17.9           | 1              |                   |
| Yes                                    | 224| 19.2           | 1.09 (0.42–2.81) | 0.001             |
| Ever injected drugs                    |    |                |                |                   |
| Positive                               | 10 | 40.0           | 1              |                   |
| Negative                               | 319| 20.1           | 0.37 (0.10–1.38) | 0.001             |
| aRDS Respondent driven sampling       |    |                |                |                   |
| bHBV Hepatitis B virus                 |    |                |                |                   |
| cHCV Hepatitis C virus                 |    |                |                |                   |
| dHTLV Human T-cell leukemia virus      |    |                |                |                   |
| eOR Odds ratio                         |    |                |                |                   |
| fCI Confidence interval                |    |                |                |                   |
| gAOR Adjusted odds ratio              |    |                |                |                   |
general. An analysis of the blood samples collected during the 2010 Demographic and Health Survey in the Burkinabé population estimated the HCV prevalence at 3.6% [41]. Systematic reviews have also estimated the pooled prevalence of HCV in the West African population between 3 and 5% [39, 42]. HCV transmission is mainly through blood, especially through transfusion with contaminated blood or nosocomial transmission with contaminated material [18]. Among MSM, there is often an increased risk of infection from injection drug use and HIV infection [8, 9, 43, 44]. In a recent systematic review, the authors found that the prevalence of anti-HCV antibodies was estimated at 40 and 6.7%, respectively, among HIV-positive MSM who were injection drug users and non-drug users [45]. Furthermore, traumatic anal sex may be involved in HCV transmission among MSM.

**HTLV 1&2 seroprevalence**

HTLV 1&2 viruses are probably among the most neglected bloodborne viruses among MSM in Africa, and data are very scarce. This first study of MSM in Burkina Faso shows that the overall seroprevalence of anti-HTLV 1&2 antibodies was 4%. This seroprevalence is higher than those reported among pregnant women in West Africa, especially in Burkina Faso in 2006 (1.02%), in Côte d’Ivoire in 1989 (1.9%), and in Ghana in 2006 (2.1%) [23]. More recently in Nigeria, Yuguda et al. reported a seroprevalence of 3.2% among blood donors in Nigeria, with all positive cases being male [46]. The high prevalence of anti-HTLV 1&2 antibodies in MSM in our study may be explained by risk behaviors [26, 47]. The factors independently associated with the presence of anti-HTLV 1&2 antibodies in our study were a history of genital lesions (penis or anus) during the last 12 months and injection drug use. Other authors have found that HTLV infection in MSM is associated with the presence of STI including syphilis or genital lesions [14, 48, 49], or injection drug use. In a study in Argentina among people who inject drugs, MSM, sex workers, and tuberculosis patients, the authors found an overall prevalence of anti-HTLV 1&2 antibodies of 2.4%, and the highest prevalence (19.1%) was among people who inject drugs [27].

Our study has a number of limitations. Participants may have underreported sensitive behaviors, including injection drug use, which is punishable by law in Burkina Faso. The study was cross-sectional, therefore it is unknown whether the identified risk factors preceded the associated infections. Also, in this seroprevalence study, the testing was based on serological methods using fourth generation ELISA. Even these methods have very high specificity and sensitivity, a positive HBsAg or HCV and HTLV antibody test does not confirm the stage of infection during the study. Finally, there are specific limitations to the RDS method. The RDS financial incentive, while modest, may encourage more low-income MSM to participate in the study and lead to selection bias. Despite these limitations, RDS was identified during the preparatory phase of data collection as the best approach to recruiting MSM in this context. In addition, our study excludes the first seroprevalence data for hepatitis B, C, and D and HTLV viruses among MSM in Burkina Faso. These data fill a gap and will help map the epidemiology of these infections among high-risk populations in Africa.

**Conclusions**

This first study shows that MSM in Burkina Faso are heavily affected by hepatitis B and C viruses and HTLV infection. However, no MSM in this study tested positive for HDV. Sexual behavioral factors, genital or anal lesions, and injection drug use may play an important role in the spread of these viruses among MSM, particularly HBV and HTLV. These results highlight the need to strengthen the prevention of STI generally among MSM, but specifically the prevention of HBV transmission through vaccination. Sexual health education, strengthening accessibility of condoms and condom-compatible lubricants, and integrated STI services in HIV programs for MSM should be considered. Similarly, interventions to increase awareness of the risks associated with injecting drugs should be undertaken among MSM to limit the spread of HTLV.

**Abbreviations**

AOR: Adjusted odds ratio; CERS: Ethics Committee for Health Research of Burkina Faso; CI: Confidence interval; ELISA: Enzyme Linked Immunoassay; HBsAg: Hepatitis B virus surface Antigen; HBV: Hepatitis B virus; HCV: Hepatitis C virus; HDV: Hepatitis D virus; HIV: Human immunodeficiency virus; HRP: Horseradish peroxidase; HTLV 1&2: Human T-cell leukemia virus types 1 and 2; Ig: Immunoglobilin; MSAT: Men who have sex with men; OR: Odds ratio; RDS: Respondent driven sampling; RDSAT: RDS Analysis Tool; TMB/H2O2: Tetra-methyl-benzidine/hydrogen peroxyde; USD: United States dollars

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**Availability of data and materials**

The datasets used during the current study are available from the corresponding author on reasonable request.
Authors' contributions
HGO, SK, NB, SB conceived and designed the study; HGO, MC, CD performed lab analysis; HGO prepared the manuscript and it was reviewed by SK, NB, AG, CR, TY, RO, SB. All authors read and approved the final manuscript.

Ethics approval and consent to participate
The study received ethical approval from the Ethics Committee for Health Research (CERS) of Burkina Faso. Participants provided written informed consent.

Consent for publication
Not applicable.

competing interests
The authors declare that they have no competing interests.

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