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Adherence to Hepatitis B vaccination schedules among health care workers in Kenya.

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Abstract

Background: Hepatitis B virus (HBV), a leading cause of acute and chronic liver disease, cirrhosis, and hepatocellular carcinoma (HCC), is the most easily transmitted blood-borne pathogen. Consequently, HBV poses a major occupational hazard for health care workers (HCWs), especially in high-endemic regions like sub-Saharan Africa. Complete multi-dose vaccination is recommended to prevent transmission, yet data on HCW adherence to HBV vaccine schedules in the region remain scarce. This study aimed to determine HBV prevalence and adherence to recommended vaccination schedules among Kenyan HCWs. Methods: This longitudinal study recruited 302 consenting HCWs from five public and private hospitals in Eldoret, Uasin Gishu County, and followed them for six months. Demographic data were obtained using questionnaires. HBV sero-prevalence was assessed using the Hepcell Rapid Test Kit. Of the participants, 298 tested HBsAg-negative and were subsequently enrolled for the three-dose HBV vaccination schedule. A vaccination register was used to document vaccine administration and ensure follow-up throughout the study period. Results: The study population had a mean age of 30.5 years and was 60.6% female. HBV prevalence was 1.3%. Among 298 HBV-negative HCWs, 90% completed all three vaccine doses, indicating a 10% non-adherence rate. Conclusion: HBsAg prevalence among HCWs in Uasin Gishu County was low, and at-risk health workers demonstrated high adherence to the recommended multidose HBV vaccination schedule.

Keywords: HBV in HCWs: prevalence & vaccination adherence study.

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1 Introduction

Hepatitis B virus (HBV) is an enveloped, partially double-stranded DNA virus that is transmitted via infected blood and bodily fluids (Trepo *et al*., 2014, Yuen *et al*., 2018). Globally, an estimated 257 million people are chronically infected with HBV, making it one of the most prevalent viral infections worldwide, and a major public health priority, particularly in highly endemic areas (Trepo *et al*., 2014, Yuen *et al*., 2018). Infection with the HBV causes hepato-cellular necrosis and inflammation, and chronic infection can lead to liver fibrosis, cirrhosis and hepatocellular carcinoma (HCC) (Yuen *et al*., 2018, Hu *et al*.,2019). It is estimated that chronic hepatitis B infection is responsible for 50% of all cases of HCC, and 25% of people with chronic hepatitis B will die prematurely from complications of the disease (Ott *et al*., 2017).

In developing countries, health care workers (HCWs) are at serious risk of infection from blood-borne pathogens, specifically HBV, hepatitis C virus (HCV), and human immunodeficiency virus (HIV), because of the high prevalence of such pathogens in the general population, particularly in sub-Saharan Africa (Belyhun *et al*., 2016, Makokha *et al*., 2023). HBV infection in particular is a well-recognized occupational hazard for HCWs who are in contact with blood, body fluids and sharp instruments. Infection may result after exposure by means of needle sticks, cuts from other contaminated sharp instruments or mucosal contact (Lee and Choi, 2023, Priya *et al*., 2015, Wilburn & Eijkemans, 2004).

Globally, there are approximately 36 million HCWs, of whom around 3 million become injured accidentally with a sharp instrument annually, resulting in 2 million cases of contamination with HBV (Lee & Choi, 2023, Priya *et al*., 2015, Wilburn & Eijkemans, 2004, Elseviers *et al*., 2014). Studies on the prevalence of HBV among HCWs from sub-Saharan African countries are still scanty. In Rwanda, a prevalence of 2.9 % chronic HBV infections among tertiary hospital employees has been reported (Kateera *et al*., 2015). In Nigeria, HBsAg-prevalence of 13 % was reported among HCWs (Ola *et al*., 2012). In East Africa, the prevalence of HBV among HCWs is estimated to be between 7 and 8% (Mueller *et al*., 2015, Ziraba *et al*., 2010), with the prevalence in Kenya ranging from 2–13% (Makokha *et al*., 2023, Kerubo *et al*., 2015, Kisangau *et al*., 2019). This poses challenges not only to HCWs who are at risk of being infected through sharp objects (Auta *et al*., 2017), but also to patients because of the potential risk of transmission from HCWs to other patients co-sharing hospital facilities (Bhat *et al*., 2012). Therefore, targeted complete anti-HBV vaccination of HCWs remains a key strategy **(**McNaughton *et al*., 2020) towards elimination of HBV by the year 2030, as espoused by WHO (WHO, 2016).

The HBV vaccine has been available since 1982 and, since 1990, has been recommended for HCWs, whose work-related activities frequently expose them to blood **(**Pattyn *et al*., 2021, Van Damme & Van, 2007). However, limited available evidence indicates that only a quarter of HCWs at risk of HBV infection, were fully vaccinated in Africa (Auta *et al*., 2018). In Kenya, the exact data on the completion rate of HBV vaccination is scanty. A previous study among HCWs in Thika district, in Central Kenya, reported a HBV vaccine coverage between 44-92%, with the highest rates being recorded in smaller health centers (Suckling *et al*., 2006).

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In Makueni, Eastern Kenya, HBV vaccination completion rate of 48% was reported among HCWs (Kisangau *et al*., 2019). These indicate great variation in vaccination completion rate among HWCs in different Kenyan regions and healthcare settings, probably driven by yet to be documented reasons or factors. Therefore, the objectives of this study were to determine the prevalence of HBV among HCWs working in selected hospitals of Eldoret town; the HBV adherence rate of this population and the factors associated with incompletion of the vaccine schedules.

2 Methods

2.1 Study design and sampling

This was a longitudinal study in which consenting HCWs, working at five selected public and private hospitals in Eldoret Town, Uasin Gishu County, were recruited, and followed up for a 6-month period. The participation was voluntary and 302 participants who accepted to participate in the study were conveniently sampled follows; Chepkanga health centre (17), Imani hospital (37), Uasin Gishu sub-county hospital (166), Cedar hospital (11) and Reale hospital (71).

2.2 Study setting

The study was carried out in Eldoret Town, which is the fifth largest town in Kenya and the administrative headquarters of Uasin Gishu County. Uasin Gishu County is located in the western region of Kenya and it borders Trans-Nzoia county to the north, Elgeyo-Marakwet County to the east and Nandi County to the south. According to the 2019 census, Uasin Gishu County had a high population density of 1,163,186 people living within an area of 3,392 km^2. The population comprises of both urban and rural populations, with the urban population living in Eldoret town and its environs. The county has 1 national teaching and referral hospital, six-sub-County hospitals, 33 health centers and 88 dispensaries, all of which are public. In addition, there are several private hospitals and clinics, particularly within Eldoret town. The study was carried out in selected public and private hospitals. Study sensitization, recruitment and screening for HBV sero-positivity of the participants was done between 1st July 2014 and 30th July 2014. The study sensitization was done by poster and oral announcement. The recruited 298 participants, who were eligible to receive HBV vaccination, were given initial doses and followed up for six months (August 1st 2014 and May 2015).

2.3 Study participants

The eligibility criteria for participation in the study were any healthcare worker working in the selected health care facilities and who consented to participate. To be included in the vaccination and follow up study of adherence, the participant ought to have been HBsAg sero-negative, with those testing sero-positive being excluded.

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2.4 Variables

The independent variables in this study were occupation, age and gender while the dependent variables included HBsAg sero-status, completion of scheduled three HBV vaccine doses. The outcomes were sero-prevalence, vaccination adherence rate and self-reported factors influencing vaccination adherence. We controlled for HBV status via a pre-screening serological testing for HBV.

2.5 Data resource and measurement

2.5.1 Data collection tool for socio-demographics

Self-administered questionnaire was used to obtain socio-demographic data of the study population. The data collected included, age, gender and occupation. This data was entered into without identifiers into an excel spread sheet that was password-protected to maintain the confidentiality of the patient.

2.5.2 Screening for HBV

Blood samples got from each participant (5ml) were assessed for HBsAg presence using KEMRI Hep-cell kit, following manufacturer's instructions. All individuals who gave blood samples received their results immediately. Persons who turned HBsAg- positive were informed that they did not require vaccination, and were referred for treatment.

2.5.3 Vaccination Schedules

Those who were HbsAg sero-negative were enrolled to take three doses (20 μg) of recombinant hepatitis B vaccine, Engerix B (SmithKline, Rixensart, Belgium), administered by intramuscular injection into the deltoid region, with a one-month interval between the first and second dose, and a five-month interval between the second and third dose (complete vaccination).

2.5.4 Follow-up data collection

The vaccination data was then entered into the vaccination register. This included the date and time of receiving each of the schedule vaccine doses. This data was later used as the source of information regarding the number of doses received by each person.

2.5.5 Collection of data on factors affecting completion of scheduled vaccines

Two weeks after last vaccination exercise, the investigators had a phone interview with participants at a dedicated phone line, where reasons linked to incomplete HBV vaccination were obtained. Prevalence of HBV was calculated as the percentage of HCW who turned seropositive. Completion rate was calculated as the percentage of enrolled HCW who completed all the three scheduled vaccines.

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2.5.6 Bias

To avoid or minimize bias in this study, attempts were made to recruit from all the health occupations at risk of HBV. This was achieved via non-biased sensitization by use of poster placed at easily accessible locations within hospitals and ensuring that oral sensitization was done in all departments. All genders and HCWs of different age groups, ethnicity and working duration were included, without any bias whatsoever. The sample was distributed proportionately to the target population size in each facility to avoid over- or underrepresentation.

2.5.7 Sample size

The minimum number of samples was calculated using the formula by Fisher *et al.*, 1998:

$$\mathbf{n=Z^2pq/d^2}$$

Where;

$Z^2=1.96^2$,

p=0.08 (p= prevalence; 8% for HBV), q = 0.92 (1-p),

$d^{2=}0.05^2$

$n =1.96^2$ X (0.08 X 0.92) / $(0.05)^2$ = 108 ≈**110** samples

2.5.8 Statistical analysis

After checking the filled questionnaires, laboratory results and phone interview findings for consistency and completeness, data were entered into Excel spreadsheet, then imported to and analyzed using the Statistical Package for the Social Sciences (SPSS for Windows, version 17.0, SPSS Inc, and Chicago, IL, USA). Descriptive statistics including means, range and frequencies were used to analyze the socio-demographic data and the occupation of all the 302 recruited participants. The analysis of the adherence rate was based on all the 298 participants who received the 1st dose. Only 29 participants who did not complete their scheduled doses were included in the analysis of factors influencing adherence. Tabulation and cross tabulation of the data was done. The association between vaccine completion and socio-demographic characteristics (sex, age) as well as occupation was done using Pearson correlation statistics. A p-value of 0.05 or less was used as a cut-off point for statistical significance.

2.5.9 Ethical Considerations

Prior to this, the study received ethical approval from KEMRI's ethical review committee (SSC 2209). In addition, permission to conduct the study was granted by various Hospital management boards, where study participants were enrolled. All the recruited participants received an explanation of the study and gave their informed consent. Overall, a committee consisting of a

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public health physician, public health nurse and specialists in laboratory medicine, among others, was constituted to oversee the operation of the study.

3 Results

3.1 Participants

A total of 302 consenting participants were initially recruited from the five selected healthcare facilities, and their socio-demographic data collected. Of these 302 participants, 4 were ineligible for vaccination because of the HBV sero-positive status. Therefore, 298 were enrolled to receive three doses of HBV vaccines, free of charge. Of these 298 participants, 29 did not receive all the three doses of HBV vaccines and were therefore included on the study of potential factors affecting vaccine completion.

3.2 Socio-demographic characteristics of the participants

Of the 302 participants, who agreed to participate in the study, 60.6% were female. The mean age was 30.5 years (range 18-66). Majority of the participants were in the age bracket of 2635 years (Figure 2A). The occupation was as follows; clinicians (n = 43), counselors (n = 15), data (n = 18), dental (n = 8), medical laboratory personnel (n = 34), nursing (n = 120), nutrition (n = 5), occupational therapy (n = 1), pharmacy (n = 15), public health officers (n = 23), physiotherapy (n = 6), radiography (n = 1) and social workers (n = 13) (Figure 2B). Majority of the participants we female (60.6%) while male were 39.6%.

3.3 HBV sero-prevalence among HCWs

Overall, a total of 4 (1.32%) HCWs tested were positive for HBsAg. Of these 4 sero-positive cases 2 (50%) were nurses, 1 (25%) was a laboratory technologist and 1 (25%) was a public health officer. When analyzed by occupation, the HBV prevalence among the nurses, laboratory technologists and public health officers was 1.67%, 2.94% and 4.34% respectively. There was no statistically significant association between occupation and seroprevalence (Pearson correlation= 0.531, P=0.644).

3.4 HBV vaccination adherence among HCWs

Out of 302 HCWs, 298 were eligible to receive HBV vaccination. Adherence was defined as completing all the scheduled doses. Among the 298 HCWs, all received the initial dose of HBV vaccine, 283 (95 %) returned for the second vaccine dose, while 268 (90 %) received the final dose (Table 1). Overall, therefore, 30 (10%) of the participants did not fully adhere to the triple vaccine dose schedule. The lowest completion rate was observed among HCWs aged between 18-25 years at 80.4%), followed in increasing order by those aged 56-65 (88.9%), 46-55(91.4%), 26-35 (91.9%). Only one participant in the age bracket of 66-90 fully completed the three scheduled doses. There was no statistically significant association between age and completion rate (Pearson correlation= 0.754, P=0.083). Among the different occupations, clinicians, laboratory technologists, social workers and nutrionists attained 100% completion rate.

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Pharmacists had a completion rate of 60% with the lowest completion rate of 0% being observed among the occupational health therapists (Table 2). Notably, however, there was no statistically significant association between occupation and completion rate (Pearson correlation= 0.357, P=0.232).

3.5 Reasons for not completing the vaccination schedule

To understand the potential reason for non-adherence to the vaccine schedules, a telephone interview of the 29 HCW who didn't fully adhere were conducted. The most common reason was "on a booster (34.5%): or had received HBV vaccination elsewhere'', and not being available during day of vaccination (27.6%). Others included HCWs not being contacted by vaccine facilitators (20.7%) (Table 3).

Table 1: HBV Vaccine Dose schedule completion rate according to age categories

Age range	**Vaccine Dose schedule completion rate**		
	1st dose N (%)	**2nd dose N (%)**	**3rd dose N (%)**
18-25	56 (100%)	50(89.3%)	45 (80.4%)
26-35	123 (100%)	120(97.6%)	113(91.9%)
36-45	74 (100%)	72 (97.3%)	69(93.2%)
46-55	35 (100%)	32 (91.4%)	32 (91.4%)
56-65	9 (100%)	8 (88.9%)	8 (88.9%)
66-90	1(100%)	1(100%)	1(100%)
Total	298 (100%)	283 (95%)	268 (89.9%)

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Table 2: HBV vaccine dose schedule completion rate according to occupation

Occupation	Vaccine Dose schedule completion rate		
	1st dose N (%)	2nd dose N (%)	3rd dose N (%)
Nursing	43 (100%)	39 (90.7%)	37 (86.05%)
Clinician	15 (100%)	15 (100%)	15 (100%)
Laboratory	18 (100%)	18 (100%)	18 (100%)
Public Health	8 (100%)	8 (100%)	7 (87.5%)
Data	33 (100%)	32 (96.97%)	31(93.94%)
Counselor	118 (100%)	110(93.22%)	103 (87.29%)
Pharmacy	5 (100%)	5 (100%)	3 (60%)
Social work	1(100%)	1(100%)	1(100%)
Dental	15 (100%)	14 (93.33%)	14 (93.33%)
Physiotherapy	22 (100%)	22 (100%)	22 (100%)
Nutrition	6 (100%)	6 (100%)	6 (100%)
Occupational Therapy	1(100%)	1(100%)	0 (0%)
Radiography	13 (100%)	12 (92.3%)	11 (84.6%)
Total	298 (100%)	283 (95%)	268 (89.9%)

Table 3: Reasons for not adhering to vaccination schedule

Reasons	Frequency N (%)
Was on a booster (been vaccinated elsewhere)	10 (34.5%)
Away from town when exercise held (Was unavailable)	8 (27.6%)
Client provided incomplete contact, thus could not be contacted (Not contacted)	6 (20.7%)
Forgot, despite being sent a message	2 (6.9%)
Exercise venue locked	2 (6.9%)
Feared pain	1 (3.4%)
Total	29 (100%)

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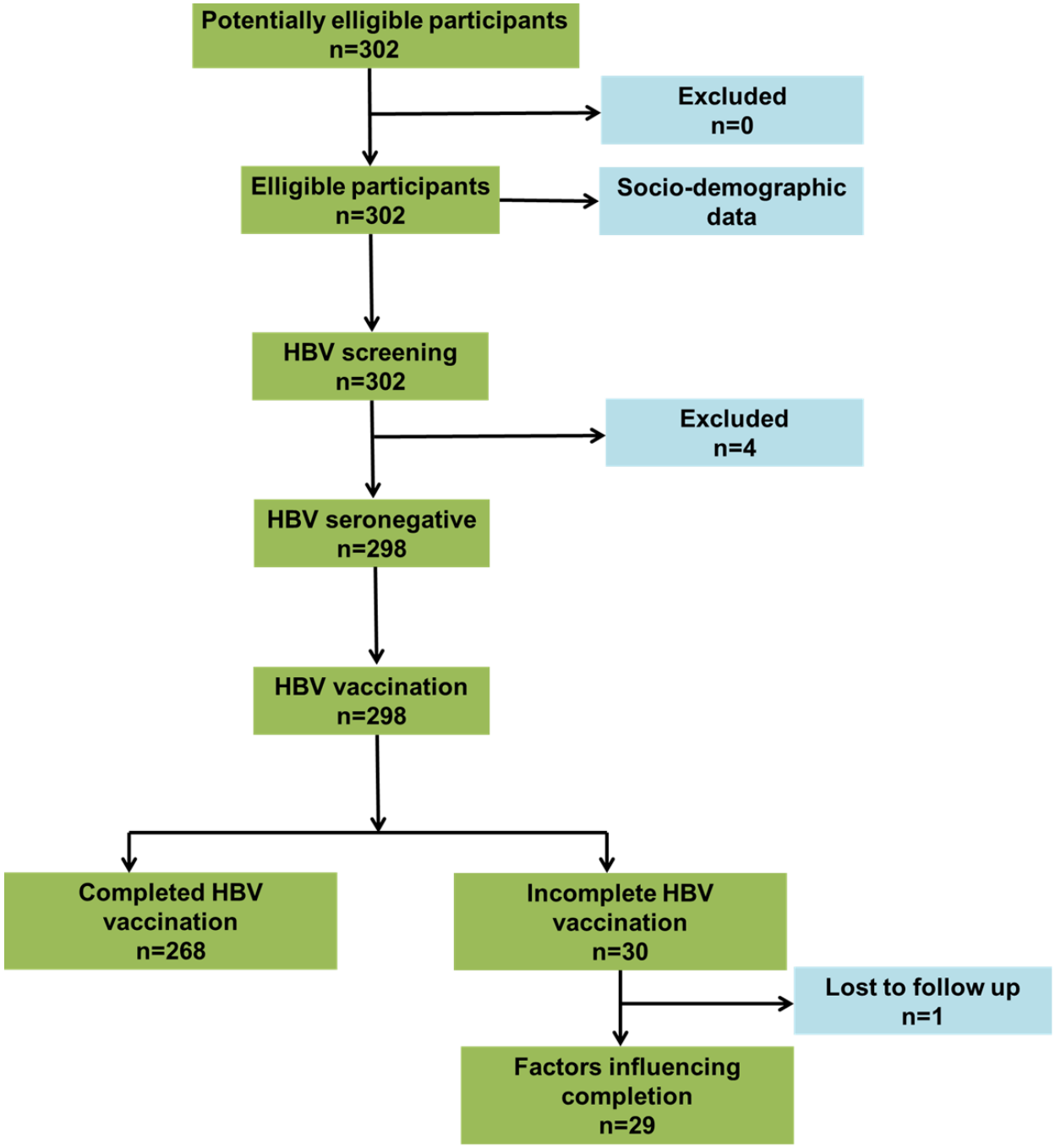

Figure 1: Flow chart showing enrollment of eligible participants

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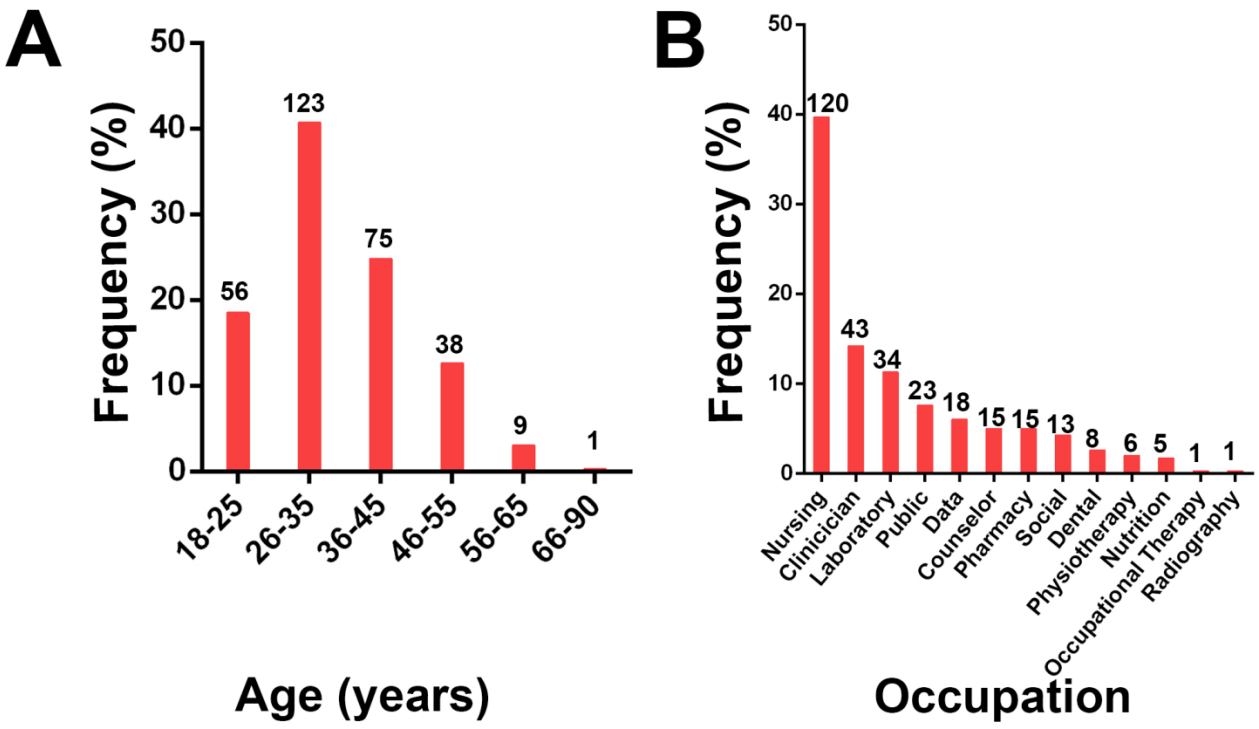

Figure 2: Graphical presentation of participant's **A)** age distribution **B)** occupation

4 Discussions

Hepatitis B virus is a non-cytopathic virus, containing a partially double-stranded DNA genome. This virus predominantly infects hepatocytes and belongs to the hepadnavirus family. HBV has an outer envelope containing HBsAg and a core containing hepatitis B core antigen (HBcAg). Excess HBsAg is produced as sub-viral particles, which circulate in the blood and permit serological diagnosis of HBV and determination of sero-prevalence (Yuen *et al*., 2018, Iannacone & Guidotti, 2022).

As HCWs might transmit HBV infection to their patients as well as to their family members (Bhat *et al*., 2012), it's necessary to determine prevalence of HBsAg-positivity among them, particularly for programmatic interventions. In the current study, we recorded a seroprevalence rate of 1.3 % among HCWs in Uasin-Gishu County. Of the 298 HBV-negative HCWs, 268 (90%) completed all the three scheduled doses, representing a non-adherence rate of 10%. A great majority of the non-adherent HCWs (34.5%) in our study cited prior vaccination as the reason behind their incompletion of the scheduled vaccines. Also, a number of them said they were not available during day of vaccination (27.6%) (Table 3).

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The sero-prevalence rate in our is somewhat similar or slightly higher to that found in past studies. For example, one study of HCWs in Turkey, the positive HBsAg rate was found to be 1.4% (Güçlü *et al*., 2015), which compares with our results. Further, a study among 5813 healthcare workers in Italy, reported a 1.8% HBsAg-positivity rate, which is close to our study finding (Petrosillo *et al*., 1995). A study from Makueni County, in Eastern Kenya, reported a 4% prevalence of HBV infection among HCWs (Kisangau *et al*., 2019), results which are higher than what we report here. Other studies, with slightly higher findings than ours, include one conducted in a tertiary level public hospital in Ethiopia, where the rate of HBsAg positivity was 2.5% (Hebo *et al*., 2019); the prevalence of 2.9% reported among healthcare workers of a tertiary hospital in Rwanda (Kateera *et al*., 2015) and the 4.2% prevalence reported among medicine and health science students of Wollo University, Northeast Ethiopia (Demsiss *et al*., 2018). Moreover, our findings was lower than the prevalence of 7.3% reported among healthcare workers of Bule Hora Woreda, Southern Ethiopia; the prevalence of 8.7% reported among health care workers of the Najran region, South-western Saudi Arabia (Alqahtani *et al*., 2014), the prevalence of 8.1% reported among healthcare workers of a tertiary hospital in Uganda (Ziraba *et al*., 2010), and the prevalence of 7.0% reported among healthcare workers of a tertiary hospital in Tanzania (Mueller *et al*., 2015). Contrastingly, our results was higher than in previous sero-prevalence studies conducted on HCWs in the United States (0.1%) (Thomas *et al*., 1993) and Brazil (0.8%) (Calleja-Panero *et al*., 2013). This might be due to the lower prevalence of HBV in the general population in those countries.

Due to the already established risky nature of their profession, HCWs practice a lot of safety precautions when dealing directly with patients or patient samples. Some of these precautions include: (a) understanding the disease and knowing their limits when taking care of a patient, (b) always wearing personal protective equipment on duty, (c) always disinfecting work areas and sterilizing re-usable working materials after use, (d) ensuring that biohazard waste materials are properly disposed or incinerated, and (e) getting vaccinated against the infection. The proper implementation of all these safety precautions by HCWs technically reduces their chances of contracting an infection (Tufon *et al*., 2019). This fact may partly explain the low level of infection in the current study.

Viral hepatitis is preventable with effective vaccines, which have been available since 1982 and have proven safe to both adults and children (Pattyn *et al*., 2021, Van Damme & Van, 2007). However, despite being safe, efficacious and cost-effective, hepatitis B vaccination remains consistently under-employed (Mast *et al*., 2006, Yuan *et al*., 2019). Therefore, assessment of HBV vaccination coverage in health care setting is needed to evaluate the potential barriers and strategies for increasing coverage. This study deliberately set out to identify the adherence to hepatitis B vaccination among the tested group. Accordingly, 298 (100 %) of them received the initial dose of HBV vaccine, while 283 (95 %) returned for the second vaccination step. This is comparable, albeit higher, to a recent Kenyan study, where 249 (80%) HCWs reported to have received ≥1 HBV vaccine dose (Kisangau *et al*., 2019). This high uptake could be attributed to high awareness among HCWs and the fact that the vaccine was provided for free of charge in our

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study. The ≥1 dose rate of vaccination among HCWs was also similar to a past study, which reported ≥1 dose rate of vaccination among HCWs of 86% (Yuan *et al*., 2019), as well as to another study (86.4%) of six cities of China[Zhang, 2011]. However, the result is higher compared to the findings reported from Zambia (45.3%), Ethiopia (57.7%), Tanzania (56.9%), Kuwait (74.4%) (Aaron *et al*., 2017, Akibu *et al*., 2018, Alnoumas *et al*., 2012, Mungandi *et al*., 2017).

Findings from the present study reveal that an average of 90 % of the HCWs had taken the three doses of the HBV vaccine. This data is, however, slightly higher than results documented in the study conducted among doctors and nurses in Iran, which reported that 86.2% completed the recommended three doses of vaccine (Hashemi *et al*., 2014).

Importantly, our findings, when compared with those of Kisangau et al – 48%, (Kisangau *et al*., 2019), Ansa et al – 42% (Ansa *et al*., 2019), Omotowo et al.– 48.9% (Omotowo *et al*., 2018) and Mueller et al.– 48.8%, (Mueller *et al*., 2015) demonstrates that the vaccination program was successful. Additionally, the percentage of those who received three doses of vaccine in the current study is higher than the findings in other studies conducted in Zambia, Burkina Faso, Nigeria, Ethiopia and Tanzania which reported 54.7, 10.9, 25.6, 61.2 and 33.6%, respectively (Aaron *et al*., 2017, Akibu *et al*., 2018, Mungandi *et al*., 2017, Ouédraogo *et al*., 2013, Abeje & Azage, 2015), further indicating that vaccination exercise was accepted by HCWs in our study.
A relatively high adherence to vaccination by HCWs realized in the current study may be connected with high perception of risk in situations, as reported previously (Topuridze *et al*., 2010). Nevertheless, the differences in this study, as compared to studies, could be attributed to the smaller sample size (302), and the fact that ours was not a survey, but a deliberate study.

Among HCWs, old age was associated with higher prevalence of vaccine dose completion, though not significantly; but it does support literature findings that highlight that age indeed is a determinant for hepatitis B vaccination in HCWs (Akibu *et al*., 2018, Mungandi *et al*., 2017, Ansa *et al*., 2019, Abebaw *et al*., 2017, Ibekwe & beziako, 2006, Nelson *et al*., 2009, Ogoina *et al*., 2014). This may be because these HCWs may have learned to appreciate their risk of being infected with hepatitis B better with longer years of service as they experience occupational accidents such as needle stick injuries during their work.

Risk factors against complete vaccination of HBV should be identified and evaluated. By eliminating these factors and providing necessary facilities, 100% vaccination coverage is well within the realm of possibility. In this regard, we document the self-declared reasons of the participants about their lack of, or incomplete, HBV vaccine uptake. A similar study among paramedics and medical technicians found that the most common reason for avoiding vaccination was being busy and not having time for it (Yuen et al., 2018, Suckling et al., 2006), a fact corroborated by our study.

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Limitations

Because of the limited budget, not all markers of HBV infection could be measured. Therefore, we were neither able to distinguish acute from chronic HBV infections, nor HCWs who were immune against HBV, or those who were still susceptible to HBV infection. Further, due to the non-random selection of participants in this survey, generalization of the results to other populations must be undertaken with caution. In spite of these, this study has provided sufficient base for developing a proper preventive guidelines and educational programs for the HBV prevention.

Conclusions

The prevalence of HBsAg among HCW in Uashin Gishu County was low. There was a high level of adherence among the at-risk participants HCWs to the multidose HBV vaccination. The presence of serological markers of HBV infection among unvaccinated study participants, stress the need for preventative measures at the population level.

Competing interests

The authors declare no competing interest.

Authors' contributions

LB contributed to the design and interpretation of data. CW analyzed the quantitative data. KO provided input on the design and methods. ND provided input on the design and methods. RE provided input on the design and methods. MEK provided input on the design and methods. KC provided input on the design and methods. SK provided input on interpretation and did critical review of the manuscript. SEM contributed to study conception design and interpretation of data. All authors read, revised and approved the final manuscript.

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Abbreviations

HBV: Hepatitis B Virus; HCWs: Health care workers; HBsAg: hepatitis B surface antigen; SERU: Scientific Ethics Review Unit; KEMRI: Kenya Medical Research Institute.

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