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Sero-prevalence of Hepatitis B virus markers among health care workers in the North West Region of Cameroon.

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Abstract

Background: Hepatitis B is a blood borne viral infection which stands out as a nosocomial infection in health care settings given that it can be contracted via contact with body fluid and infection is almost always asymptomatic. However, there exist a safe and available vaccine which confers about 96% protection from a Hepatitis B virus (HBV) infection.

Objective: Determine the prevalence of the different HBV serological profiles among healthcare workers in the North West Region of Cameroon.

Methods: A cross-sectional hospital based study was carried out over a 6 months period during which 395 health care workers from all health facilities in the Bamenda Health District, NWR, Cameroon, registered at the regional delegation of health were recruited. Their serum was tested for the presence of HBV core antibody (anti-HBc), Hepatitis B surface antibody (anti-HBs), HBV e antibody (anti-HBe) and Hepatitis B surface antigen (HBsAg) using MONALISA ELISA kits.

Results: Among the 395 participants, 68.4% of them were females, 47.3% (187) had been exposed to HBV (reactive for anti-HBc), 36.7% (145) succeeded in resolving the infection (reactive for anti-HBc and anti-HBs), 10.6% (42) were current HBV carriers (HBsAg positive), 2.5% (10) were infective (reactive for anti-HBc and HBsAg but non-reactive for anti-HBe and anti-HBs), 9.1% (36) were vaccinated (reactive for anti-HBs and non-reactive for anti-HBc) and 43.5% (172) were still susceptible to the infection (negative for all HBV serological markers). There was a significant association between exposure, past infection, susceptibility and age.

Conclusion: The prevalence of HBV exposure and infection among HCWs obtained in this study was high while the level of vaccination in this at risk population was low. Adequate steps should be taken to sensitize this population on HBV and the vaccination procedure.

Keys words: HBV, HCWs, antigen, antibody.

Abbreviations: HBV: Hepatitis B virus, anti-HBc: hepatitis B core antibody, anti-HBs: Hepatitis B surface antibody, anti-HBe: HBV e antibody, HBsAg: Hepatitis B surface antigen, MD: Medical doctor, Lab tech: Laboratory technician, HCWs: Health care workers, SRN/SRM: State Registered Nurse/Midwife, NWR: North West Region, HND: Higher National Diploma, BSc: Bachelor of Science, HBsAg: Hepatitis B surface antigen, ELISA: Enzyme-linked immunosorbent assay, CMA: Centre medical d'arrondisement (district medical centres).

Strength:

- Monalisa™ ULTRA ELISA kits with 100% sensitivity and specificity of 99.28% was used to determine current HBV infection (HBsAg positivity).
- Stratified sampling technique, which permits estimation of population parameters for groups within population was used for sampling.

Limitation:

- The anti-HBs titer was not quantified thus the percentage of HCWs considered to be vaccinated in this study is higher than the actual percentage with a protective level of anti-HBs.
- Liver biopsy was not done to prove the complete clearance of the virus in resolved infection. Resolved infection was assumed when anti-HBs was positive but HBsAg was negative. Thus the prevalence of resolved infection may have been over-estimated.
- The present study covers a cross-section of health professionals, so caution should be taken while generalizing the results.

INTRODUCTION

Hepatitis B infection is a viral infection that attacks the liver and can cause both acute, self-resolving, and chronic disease (1). The Hepatitis B virus (HBV), made of a partially double stranded DNA belongs to the family of Hepadnaviridae. This virus found in both blood and body fluids of infected persons, can be transmitted to the mucus membrane or blood stream of non-infected persons (1). Infection with HBV is preventable with the presence of a vaccine which confers over 96% protection to recipients (2). According to the WHO fact sheet updated in July 2018, an estimated 257 million people are infected with HBV worldwide and more than 887,000 people died in 2015 due to complications of HBV including cirrhosis and hepatocellular carcinoma (3). The level of hepatitis B varies widely across WHO regions with the WHO African Region and the WHO Western Pacific Region sharing the greatest burden (6.1% and 6.2% of the population respectively). In Cameroon, a sub-Saharan African country, HBV infection is considered hyper-endemic with a prevalence rate estimated at 11.5% (4). Health-care workers (HCWs) whose job is to care for the sick and injured are often exposed to blood and other body fluids in the course of their work. Consequently, they are at increased risk of infection with blood borne viruses such as HIV, HBV and HCV (5). The risk of infection for health workers depend on the prevalence of the disease in the patient population and the nature and the frequency of exposures (6). HCWs when infected, are at risk of transmitting HBV to their patients (6). Because of the risk associated with their occupation, WHO recommends that all non-infected health care workers be vaccinated against HBV (5).

A national survey in Cameroon on the prevalence of HBV among HCWs reported a national sero-prevalence of 8.75% current infection in this at-risk group (7). The prevalence of HBV among HCWs in the North-West Region was 8%, higher than that obtained in other regions like the West (5.7%) and the East (4.7%) but lower than what was obtained in the South (12%) and the Far North (24%) regions of the country. A recent study carried out among HCWs in this region reported a prevalence of 10.6% (8). This study like most of the other studies carried out in the country focused only on the prevalence of current HBV infection (HBsAg positivity). Very little work has been done on the other HBV serological markers (anti-HBC, anti-HBs, anti-HBe and HBeAg) to evaluate exposure, natural immunity (past or resolved infection), infectivity, vaccination

(acquired immunity) and susceptibility. Among these, Tatsilong *et al*., working with HCWs in a hospital in Yaoundé reported a prevalence of 11% current infection, 8 % natural immunity, 19 % vaccinated and 62 % susceptible subjects (9) while Yu-Ling Qin *et al*., working with HCWs in Sierra Leone reported 10.0% current infection, 4.3% past infection, 4.3% acquired immunity, 0.5% infective subjects and 81.5% susceptible subjects (10)

In this study, we therefore set out to evaluate the different serological markers associated with HBV infection (anti-HBc, anti-HBs, HBsAg and anti-HBe). These serological markers were used to evaluate the prevalence of exposure, natural immunity, current infection, infectivity, acquired immunity and susceptibility to HBV among HCWs in our setting Knowledge on these relevant HBV epidemiological features in this at-risk group can assist in the development of specific programs such as vaccination campaigns for susceptible HCWs and guide health policy makers in prioritizing and optimizing treatment of infected and/or infective HCWs. This in turn can help public health surveillance institutions in our resource-limited setting to optimizes the available resources.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional hospital-based study conducted between April and September 2017. The study included 22 health facilities in the Bamenda health district (one regional hospital, three CMAs (Centre medical d'arrondissement), six mission hospitals, five government health centres and seven private hospitals). Testing stations were set up in the various wards of the health facilities. Over 70% of HCWs in the various health facilities were recruited for this study.

Case definition

In this study, exposure was defined as being tested positive for the antibody anti-HBc only, natural immunity (past/resolved infection) was being tested positive for anti-HBc and anti-HBs, current infection was defined as was being tested positive for the antigen HBsAg, infective subjects were those who were tested positive for HBsAg and negative for anti-Hbe, vaccinated subjects were those who were positive for anti-HBs only while

susceptible (naïve) subjects were those who were negative for all HBV serological markers. Being tested positive implies they were reactive for the marker of interested.

Sample size and justification

Sample size was determined using the formula proposed by Scott Smith for determining population proportion sample size (11): X=Z-score × SD × (1−SD)/MOE. The proportion of HCWs in NWR was obtained from a registry which published the national proportions of HCWs per region in 2015 (12). The confidence level was 95%, giving a Z-score of 1.96, a margin of error (MOE) of ±5 and an SD of 0.5. The calculated sample size using this formula was 385 persons.

Sample collection

All HCWs present in the Bamenda Health District during the study were invited to participate in this study. HCWs who consented to the study were asked to sign a consent form, fill a self-administered questionnaire after which 4ml of blood was collected from them into a red cap (dry) tube. Identification number was used to link participant's laboratory results and the questionnaire. A standardized questionnaire designed by the researcher was used to collect socio-demographic data and HCWs category. HCWs included medical doctors, nurses, laboratory technicians, dentist, pharmacist and hospital auxiliary staff (cleaners, carriers, launders).

HBV serology

Different MONOLISA ELISA kits obtained from Bio-Rad (Marnes-La-Coquette-France) were used to test for the presence of total anti-HBc, anti-HBs, HBsAg and anti-HBe. All ELISA assays were performed according to manufacturer's instructions.

Statistical analysis

Statistical analysis was performed using the Statistical software IBM@ SPSS@ Statistics Version 22.0 for mac. Continuous data were expressed as median values with 1st and 3rd interquartile ranges (IQR). Categorical data were expressed as percentages. Pearson's $\chi 2$ ($p<.05$) was used to assess the significance among study variables. Odd ratio (OR) was used to evaluate the strength of association between study variables.

RESULTS

Characteristics of study population

A total of 395 health care workers from the different hospitals in this region participated in the study. Among these, 68.4% (270) were women (Table 1). The 16 to 25 years old age group was the largest, representing 42.0% of the study population. The median age of the study population was 27.0 years (IQR, 23 - 32 years). Among the HCWs category, nurses were the most represented 224 (56.3%).

Exposure to HBV

Anti-HBc was used to determine exposure to HBV (Table 2). Of the 395 health care workers who participated in this study, 187 (47.3%) were tested positive for anti-HBc. A statistically significant association was observed between exposure and age (p-value<.001) and exposure to HBV increased with age. There was no significant association between sex, HCWs category and exposure. However, exposure was relatively lower among dentist (26.7%) than among other HCWs. Prevalence of exposure was similar between sexes.

Natural immunity against HBV (HBV clearance)

A combination of anti-HBc and anti-HBs was used to evaluate natural immunity against HBV (past/resolved infection) (Table 2). One hundred and forty-five (77.5%) HCWs who had come in contact with HBV had effectively cleared the virus. Natural immunity was significantly associated with age (p-value<.01), and the (35-45) year age group scored the highest prevalence (n=28, 54.9%) of HBV clearance. There was no significant correlation between ability to clear the hepatitis B virus, sex and HCWs category.

Current infection to HBV

HBsAg was detected in 42 of the 395 HCWs (10.6%) (Table 2). There was no statistically significant association between sex, age, HCWs category and current infection. HBsAg infection was higher among females (n=33, 12.2%) than among males (n=9, 7.2%). Majority of HBsAg infected HCWs belonged to the (45-65) year age group (n=4, 16.7%) and were dentist (n=2, 13.3%).

HBV infectivity among HCWs

The presence of HBsAg and the absence of anti-HBe were used to evaluate HBV infectivity (Table 2). Among the 10.4% of HCWs infected with HBV, (n=10, 23.8%) of them were infective. There was no significant association between sex, age, job and being HBV infective. More females were infective (n=8, 3.0%) compared to males (n=2, 1.6%). The (46-65) year age group recorded the highest prevalence of infective HCWs (n=2, 8.3%), just like pharmacist (12.5%).

Acquired immunity (vaccinated) HCWs

The absence of anti-HBc and the presence of anti-HBs were used to determine vaccinated HCWs (Table 2). Among the 208 HCWs who had never been exposed to HBV, (n=36, 17.3%) of them were vaccinated. There was no statistically significant association between being vaccinated, HCWs category, age and sex. Males and females had a similar prevalence of acquired immunity (12 [9.6%] males and 24 [8.9] females). Most of those vaccinated belonged to the (26-35) year age group (n=15, 9.7%) and were dentist (n=4, 26.7%).

Susceptible HCWs

Susceptibility was determined by the absence of both anti-HBc, anti-HBs and HBsAg in serum (Table 2). Among the 395 HCWs who participated in this study, (n=172, 43.5%) of them were still susceptible to HBV. There was a significant association between age and susceptibility (p-value<.01). Susceptibility significantly decreased with age and was highest in the (16-25) year age group (n=90, 54.2%). There was no significant association between susceptibility, sex and HCWs category.

DISCUSSION

Hepatitis B virus is a major cause of Chronic Hepatitis, Liver Cirrhosis and Hepatocellular Carcinoma. As a viral infection, which can be transmitted via percutaneous and mucosal exposure to infective body fluids, HBV stands as a serious nosocomial infection in health care settings. The current study, which aimed at evaluating the sero-prevalence of the different HBV serological profiles among HCWs in the NWR of Cameroon showed a high HBV burden in this population. Serological testing revealed that HBV exposure was 47.3%, past infection was 36.7%, current infection was 10.6%, infectivity was 2.5%, acquired immunity was 9.1% and susceptibility was 43.5%. A number of epidemiological

and cross-sectional studies have reported marked variation in the prevalence of the various HBV serological profiles among HCWs within and out of the country (7–10,13–15). HBV prevalence in this at-risk group seems to vary with the HBV prevalence in the general population.

The high prevalence of HBV exposure (47.3%) obtained in the current study is comparable to the 44.5% obtained among HCWs in Tanzania in 2015 (13) but relatively higher than the 19% obtained in Yaoundé in 2016 (9) and the 14% obtained in Sierra Leone in 2018 (10). The relatively higher prevalence of HBV exposure obtained in this study compared to that obtained by Tasilong *et al* in Yaoundé could be a result of the diagnostic technique used, given that Tasilong *et al* worked with the one-step, rapid strip test which has a lower sensitivity and specificity when compared to the ELISA technique used in this study (16–19).

The prevalence of HBV infection obtained in this study was 10.6%. This prevalence is higher than the 8.75% obtained by Ndongo *et al*. in their national survey in Cameroon (7). The lower prevalence could be justified by the fact that the national survey focused on the regional hospital (which represents the government reference hospital in this region) and the difference in technique used (rapid strip test). Still, a similar study carried out in Yaoundé in 2016 among HCWs in a hospital located there found a comparable prevalence among HCWs [11%) (8) while Loriette *et al*., working in the Extreme Nord Region of Cameroon recorded a prevalence of 18% (12). This alternating prevalence, could actually be a reflection of the cultural and climatic differences existing between the different ethnic groups alongside the diverse geographical scenery of the country (7).

Prevalence of exposure and natural immunity were significantly associated with age. In effect, it is known that the clinical course and outcome of HBV infection is greatly influenced by age at infection, the level of HBV replication and the host immune status (20). But according to Ott J. *et al*., the decrease in exposure with age could be explained by the expanded immunization between 1990 to 2005 which led to a decrease in HBV infections in most regions particularly Central sub-Saharan Africa (21). Furthermore, risk of transmission might have changed over time due to increased awareness and precautions like wearing of gloves, frequent hand washing and use of safety needles.

The prevalence of infectivity was 2.5% for all the HCWs and 23% for HBV infected HCWs. The persistence of HBeAg in blood is always associated with progress towards a liver disease as well as an increase probability of transmitting the virus. Even though there exist a management guide proposed by WHO in 2015, this high prevalence of infectivity among infected HCWs could be because of the elevated cost involve in managing the disease (2).

According to CDC updates HBV vaccination guidelines for HCWs (2014), healthcare personnel should be vaccinated against hepatitis B virus (HBV) before exposure to blood or body fluids and should receive serologic testing to assess for antibody against the virus (22). Still, just 9.1% of HCWs in our setting showed acquired immunity. According to Ndongo et al., auxillary staff were the least likely to be vaccinated compared to the other HCWs accounting for the low prevalence of acquired immunity (4.9%) among them (7). HCWs belonging to the (16-25) year age group were the most vaccinated. This might be because of the expanded immunization between 1990 to 2005 in most regions in Central sub-saharan Africa invoked earlier (21). Also, some institution now ask for proof of HBV vaccination in none-infected individuals before hire or matriculation. Overall the low prevalence of HCWs vaccinated against HBV might either be due to inappropriate sensitization on HBV or the cost of the HBV vaccine.

HBV susceptibility in our study was high (43.5%) and was inversely proportional to age. The statistically significant association between age and susceptibility to HBV might be explained by the decrease in childhood and maternal transmission of HBV due to the expanded immunization between 1990 to 2005 explained above (21). More so, duration in the hospital increases with age. Thus, the younger HCWs whose duration in healthcare settings is less than that of older HCWs and who still have a longer period to work in this settings have not been exposed to HBV nosocomial risk factors like older HCWs and have a higher risk of eventually getting exposed when compared to older HCWs.

CONCLUSION

This study revealed a considerable burden (10.6% current infection) of HBV infection in the Bamenda health District, North West Region of Cameroon. Among the infected HCWs,

23.8% of them were infective. These infective HCWs are at risk of infecting their patients. Subsidizing management of HBV for HCWs might reduce the prevalence of infective HCWs and consequently the probability of HBV nosocomial infection from HCWs to their patients. Prevalence of HBV vaccination was low (9.1%) while prevalence of exposure (47.3%) and susceptibility (43.5%) to HBV was high in our setting. There is thus a high need for sensitization of HCWs in this area on HBV transmission and prevention. This sensitisation along with an effective and massive vaccination campaign should be carried out in this region not only among HCWs but in the population in general.

DECLARATIONS

Statement of Ethics: Ethical clearance for the study was obtained from the National Ethics Committee of Cameroon (N°2017/02/871/CE/CNERSH/SP). Authorization to carry out research in the NWR was obtained from the regional delegation. Authorizations to access different hospitals were obtained from the directors or the in-charge of the hospitals. Authorization to access health centers was obtained from the District medical officer (DMO) and the chief of centers of the health facilities in this region. Written informed consent was obtained from each participant.

Consent for publication: Not applicable.

Availability of data and material: Data are available in a public, open access repository (https://doi.org /10.6084/m9. gshare.9641771).

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

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Authors' contribution: AE and TC designed the study; AE and NRipa performed the experiments; AE drafted the manuscript; TC, NR, AL, KJR and KS were involved in editing the manuscript; AE and KS performed the statistical analysis. All authors read and approved the final manuscript.

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Table 1: Baseline characteristics of the study population

Variables	Frequency (395)	Percentage (100%)
Sex		
Male	125	31.6
Female	270	68.4
Age Intervals		
16-25	166	42.0
26-35	154	39.0
36-45	51	12.9
46-65	24	6.1
Job		
Nurses	224	56.7
Lab Technicians	90	22.8
Medical Doctors	17	4.3
Dentist	15	3.8
Pharmacist	8	2.0
Auxiliary Staff	41	10.4

Data are n(%)

Table 2: Distribution of HBV profile group (n=395)

Variables n(%)		**Exposure 187(47.3)**	**Past Infection 145(36.7)**	**Current Infection 42(10.6)**	**Infectivity 10(2.5)**	**Vaccination 36(9.1)**	**Susceptibility 172(43.5)**
Sex	Male (125)	57(45.6)	48(38.9)	9(7.2)	2(1.6)	12(9.6)	56(44.8)
	Female (270)	130(48.1)	97(35.7)	33(12.2)	8(3.0)	24(8.9)	116(43.0)
	p-value	.358	.357	.089	.337	.476	.407
Age	16-25 (166)	60(36.1)	46(27.7)	14(8.4)	4(2.4)	16(9.6)	90(54.2)

	26-35 (154)	78(50.6)	59(38.3)	19(12.3)	3(1.9)	15(9.7)	61(39.6)
	36-45 (51)	33(64.7)	28(54.9)	5(9.8)	1(2.0)	3(5.9)	15(29.4)
	46-65 (24)	16(66.7)	12(50.0)	4(16.7)	2(8.3)	2(8.3)	6(25.0)
	p-value	**<.001**	**<.01**	.518	.313	.852	**<.001**
Job	Nurse (224)	116(51.8)	88(39.3)	28(12.5)	7(3.1)	15(6.7)	93(41.5)
	Lab Technicians (90)	35(38.9)	27(30.0)	8(8.9)	0(0.0)	11(12.2)	44(48.9)
	Medical Doctors (17)	8(47.1)	7(41.2)	1(5.9)	1(5.9)	2(11.8)	7(41.2)
	Dentist (15)	4(26.7)	2(13.3)	2(13.3)	0(0.0)	4(26.7)	7(46.7)
	Pharmacist (8)	3(37.5)	2(25.0)	1(12.5)	1(12.5)	2(25.0)	3(37.5)
	Auxiliary Staff (41)	21(51.2)	19(46.3)	2(4.9)	1(2.4)	2(4.9)	18(43.9)
	p-value	.187	.147	.687	.217	**.039**	.896

Data are n(%); p-value<0.05 is considered significant.

STROBE (Strengthening The Reporting of OBservational Studies in Epidemiology) Checklist

A checklist of items that should be included in reports of observational studies. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Section and Item	Item No.	Recommendation	Reported on Page No.
Title and Abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/Rationale	2	Explain the scientific background and rationale for the investigation being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	
Methods			
Study Design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	

Section and Item	Item No.	Recommendation	Reported on Page No.
Data Sources/ Measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	
Study Size	10	Explain how the study size was arrived at	
Quantitative Variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical Methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive Data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome Data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	

Section and Item	Item No.	Recommendation	Reported on Page No.
Main Results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other Analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key Results	18	Summarise key results with reference to study objectives	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Cross-sectional hospital based-study on the sero-prevalence of Hepatitis B virus markers among health care workers, NWR, Cameroon.

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Cross-sectional hospital based-study on the sero-prevalence of Hepatitis B virus markers among health care workers, NWR, Cameroon.

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Abstract

Background: Hepatitis B virus (HBV) infection is a major public health issue worldwide, with about 257 million people reported to be chronic carriers by the World Health Organization factsheet updated in 2018. HBV can be contracted via direct contact with infected body fluid and infection is almost always asymptomatic. Although healthcare workers (HCWs) are at high risk of HBV infection, little is known about the prevalence of the various HBV markers among HCWs in Cameroon. The present study was taken to evaluate the prevalence of different HBV serological markers among HCWs in the North-West Region of Cameroon.

Methods: This cross-sectional hospital based study was carried out between April to September (2017) during which 395 HCWs were recruited. The serum of the HCWs were tested for the presence of HBV core antibody (anti-HBc), Hepatitis B surface antibody (anti-HBs), Hepatitis B e antibody (anti-HBe) and Hepatitis B surface antigen (HBsAg) using Monalisa™ ELISA kits produced by BIO-RAD laboratories. Data was analysed using SPSS version 20.0.

Results: Among the 395 participants, 270 (68.4%) of them were females, 187 (47.3%) had been exposed to HBV, 145 (36.7%) had resolved the infection, 42 (10.6%) were current HBV carriers, 10 (2.5%) were infective, 36 (9.1%) were vaccinated and 172 (43.5%) were still susceptible. Exposure to HBV, past infection and susceptibility were significantly associated with age while the rate of vaccination was significantly associated with the job of the HCW in the health facilities.

Conclusion: The prevalence of HBV exposure and infection among HCWs obtained in this study was high while the level of vaccination in this at-risk population was low. Adequate steps should be taken to sensitize this population on HBV and the vaccination procedure.

Keys words: Hepatitis B Virus, Healthcare Workers, HBsAg, Anti-HBs, Anti-HBc, Anti-HBe.

Abbreviations: anti-HBc: hepatitis B core antibody, anti-HBs: Hepatitis B surface antibody, anti-HBe: HBV e antibody, HBsAg: Hepatitis B surface antigen, MD: Medical doctor, Lab tech: Laboratory technician, HCWs: Health care workers, SRN/SRM: State Registered Nurse/Midwife, NWR: North West Region, HND: Higher National Diploma, BSc: Bachelor of Science, HBsAg: Hepatitis B surface antigen, ELISA: Enzyme-linked immunosorbent assay, CMA: Centre medical d'arrondisement (district medical centres).

Strength:

- Monalisa™ ULTRA ELISA kits with 100% sensitivity and specificity of 99.28% was used to determine HBV serological markers.
- Stratified sampling technique, which permits estimation of population parameters for groups within population was used for sampling.

Limitation:

- The anti-HBs titer was not quantified thus the percentage of HCWs considered to be vaccinated in this study is higher than the actual percentage with a protective level of anti-HBs.
- Liver biopsy was not done to prove the complete clearance of the virus in resolved infection.
- Serum HBV DNA was not measured since there is no kit available yet to determine this marker.
- The present study covers a cross-section of health professionals, so caution should be taken while generalizing the results.

INTRODUCTION

Hepatitis B virus infection is a viral infection that attacks the liver and can cause both acute, self-resolving, and chronic disease (1). The Hepatitis B virus (HBV), made of a partially double stranded DNA belongs to the family of Hepadnaviridae. This virus found in both blood and body fluids of infected persons, can be transmitted to the mucus membrane or blood stream of non-infected persons (1). Infection with HBV is preventable with the presence of a vaccine which confers over 96% protection to recipients (2). According to the WHO fact sheet updated in July 2018, an estimated 257 million people are infected with HBV worldwide and more than 887,000 people died in 2015 due to complications of HBV including cirrhosis and hepatocellular carcinoma (3). The level of hepatitis B varies widely across WHO regions with the WHO African Region and the WHO Western Pacific Region sharing the greatest burden (6.1% and 6.2% of the population respectively). In Cameroon, a sub-Saharan African country, HBV infection is considered hyper-endemic with a prevalence rate estimated at 11.5% (4).

Health-care workers (HCWs) whose job is to care for the sick and injured are often exposed to blood and other body fluids in the course of their work. Consequently, they are at increased risk of infection with blood borne viruses such as Human Immunodeficiency virus (HIV), HBV and Hepatitis C Virus (5). The risk of infection for health workers depend on the prevalence of the disease in the patient population and the nature and the frequency of exposures (6). HCWs when infected, are at risk of transmitting HBV to their patients (6). Because of the risk associated with their occupation, WHO recommends that all non-infected health care workers be vaccinated against HBV (5).

A national survey in Cameroon on the prevalence of HBV among HCWs reported a national sero-prevalence of 8.75% current infection (7) while a recent study carried out among HCWs in this region reported a prevalence of 10.6% (8). Very little work has been done on the various HBV serological markers (anti-HBC, anti-HBs, anti-HBe and HBeAg) to evaluate exposure, natural immunity (past or resolved infection), infectivity, vaccination (acquired immunity) and susceptibility (9,10). In this study, we therefore set out to evaluate the different serological markers associated with HBV infection (anti-HBc, anti-HBs, HBsAg and anti-HBe). These serological markers were used to evaluate the

prevalence of exposure, natural immunity, current infection, infectivity, acquired immunity and susceptibility to HBV among HCWs in our setting. Knowledge on these HBV epidemiological features can assist in the development of specific programs such as vaccination campaigns for susceptible HCWs and guide health policy makers in prioritizing and optimizing treatment of infected and/or infective HCWs. This in turn can help public health surveillance institutions in our resource-limited setting to optimize the available resources.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional hospital-based study conducted between April and September 2017. The study included 22 health facilities in the Bamenda health district (one regional hospital, three CMAs (Centre medical d'arrondissement), six mission hospitals, five government health centres and seven private hospitals). Testing stations were set up in the various wards of the health facilities. Over 70% of HCWs in the various health facilities were recruited for this study.

Case definition

In this study, exposure was defined as being tested positive for the anti-HBc only, natural immunity (past/resolved infection) was being tested positive for anti-HBc and anti-HBs, current infection was defined as being tested positive for HBsAg, infective subjects were those who were tested positive for HBsAg and negative for anti-HBe, vaccinated subjects were those who were tested positive for anti-HBs only while susceptible (naïve) subjects were those who were negative for all HBV serological markers. Being tested positive implies they were reactive for the marker of interest.

Sample size and justification

Sample size was determined using the formula proposed by Scott Smith for determining population proportion sample size (11): X=Z-score × SD × (1−SD)/MOE. The proportion of HCWs in the NWR was obtained from a registry which published the national proportions of HCWs per region in 2015 (12). The confidence level was 95%, giving a Z-score of 1.96, a margin of error (MOE) of ±5 and an SD of 0.5. The calculated sample size using this formula was 385 persons.

Sample collection

All HCWs present in the Bamenda Health District (BHD) during the study were invited to participate in this study. HCWs who consented to the study were asked to sign a consent form, fill a self-administered questionnaire after which 4ml of blood was collected from them into a red cap (dry) tube. Identification number was used to link participant's laboratory results and the questionnaire. A standardized questionnaire designed by the researcher was used to collect socio-demographic data and HCWs category. HCWs included medical doctors, nurses, laboratory technicians, dentist, pharmacist and hospital auxiliary staff (cleaners, carriers, launders).

HBV serology

Monalisa™ ELISA kits produced by BIO-RAD laboratories with sensitivity and specificity greater than 99% were used to qualitatively determine the different HBV serological markers. Monolisa™ HBsAg ULTRA ELISA kit was used to test for the presence of HBsAg, Monolisa™ Anti-HBs PLUS ELISA kit (BIORAD, Marnes- La-Coquette-France), was used to test for the presence of anti-HBs, Monolisa™ Anti-HBc PLUS ELISA kit was used to test for the presence of anti-HBc while Monolisa™ HBe Ag-Ab PLUS ELISA kit (BIORAD, Marnes- La-Coquette-France) was used to test for the presence of anti-HBe.

Statistical analysis

Statistical analysis was performed using the Statistical software IBM@ SPSS@ Statistics Version 22.0 for mac. Continuous data were expressed as median values with 1st and 3rd interquartile ranges (IQR). Categorical data were expressed as percentages. Pearson's $\chi 2$ ($p<.05$) was used to assess the significance among study variables. Odd ratio was calculated using binary logistic regression.

RESULTS

Characteristics of study population

A total of 395 health care workers (HCWs) from the different hospitals in this region participated in the study. Among these, 68.4% (n=270) were women (Table 1). The (16-25 years old age group represented 42.0% (n=166) of the study population. The median

age of the study population was 27.0 years (IQR, 23 - 32 years). Nurses were the most represented in the HCWs category, (n=224, 56.3%).

Exposure to HBV

Anti-HBc was used to determine exposure to HBV (

Table 2). Of the 395 health care workers who participated in this study, 187 (47.3%) were tested positive for anti-HBc. A statistically significant association was observed between exposure and age (p-value<.001). Exposure to HBV significantly increased with age and HCWs belonging to the (46-65) years age group had a greater than 3.5 times probability of being exposed to HBV when compared to those belonging to the (16-25) years age group. There was no significant association between sex, HCWs category and exposure. However, exposure was relatively lower among dentist (n=4, 26.7%) than among other HCWs. Prevalence of exposure was similar between sexes.

Natural immunity against HBV (HBV clearance)

A combination of anti-HBc and anti-HBs was used to evaluate natural immunity against HBV (past/resolved infection) (

Table 2). One hundred and forty-five (77.5%) HCWs who had come in contact with HBV had effectively cleared the virus. Natural immunity was significantly associated with age (p-value<.05), and was highest in the (36-45) year age group (n=27, 54.0%). HCWs belonging to the (36-45) year age group showed a 3 times significantly greater probability of resolving the infection when compared to HCWs belonging to the (16-25) year age group. There was no significant correlation between ability to clear the hepatitis B virus, sex and HCWs category.

Current infection to HBV

HBsAg was detected in 42 of the 395 HCWs (10.6%) (Table 3). There was no statistically significant association between sex, age, HCWs category and current infection. HBsAg infection was higher among females (n=33, 12.2%; 1.795, 95%CI[0.831-3.875]) than among males (n=9, 7.2%). Majority of HBsAg infected HCWs belonged to the (46-65) year age group (n=4, 16.7%) and were dentist (n=2, 13.3%).

HBV infectivity among HCWs

The presence of HBsAg and the absence of anti-HBe were used to evaluate HBV infectivity (Table 3). Among the 10.4% of HCWs infected with HBV, 23.8% (n=10) of them were infective. There was no significant association between sex, age, job and being HBV infective. More females were infective (n=8, 3.0%) compared to males (n=2, 1.6%). The (46-65) year age group recorded the highest prevalence of infective HCWs (n=2, 8.3%) and were pharmacist (n=1, 12.5%).

Acquired immunity (vaccinated) HCWs

The absence of anti-HBc and the presence of anti-HBs were used to determine vaccinated HCWs (

Table 2). Among the 208 HCWs who had never been exposed to HBV, 17.3% (n=36) of them were vaccinated. This gave us a general vaccination prevalence of 9.1% among the 395 study participants. There was a statistically significant association between being vaccinated and HCWs category (p-value<.05). Nurses (n=15, 6.7%; 0.197, 95%CI[0.056-0.695], p-value=.012) and auxiliary staff (2, 4.9%; 0.141, 95%CI[0.023-0.874], p-value=.036) had a significantly lower probability of being vaccinated when compared to dentist. Males and females had a similar prevalence of acquired immunity (12 [9.6%] males and 24 [8.9%] females). Most of those vaccinated belonged to the (26-35) year age group (n=15, 9.7%) and were dentist (n=4, 26.7%). However, there was no significant association between acquired immunity, sex and job.

Susceptible HCWs

Susceptibility was determined by the absence of anti-HBc, anti-HBs and HBsAg in serum (Table 3). Among the 395 HCWs who participated in this study, 43.5% (n=172) of them were still susceptible to HBV. A statistically significant association was observed between age and susceptibility (p-value<.001). Susceptibility significantly decreased with age and was highest in the (16-25) year age group (n=90, 54.2%). There was no significant association between susceptibility, sex and HCWs category.

DISCUSSION

Hepatitis B virus is a major cause of Chronic Hepatitis, Liver Cirrhosis and Hepatocellular Carcinoma. As a viral infection, which can be transmitted via percutaneous and mucosal exposure to infective body fluids, HBV stands as a serious nosocomial infection in health care settings. The current study, which aimed at evaluating the sero-prevalence of the different HBV serological profiles among HCWs in the NWR of Cameroon showed a high HBV burden in this population. Serological testing revealed that the prevalence of HBV exposure was 47.3%, past infection was 36.7%, current infection was 10.6%, infectivity was 2.5%, acquired immunity was 9.1% and susceptibility was 43.5%. A number of epidemiological and cross-sectional studies have reported marked variation in the prevalence of the various HBV serological profiles among HCWs within and out of the country (7–10,13–15). HBV prevalence in this at-risk group seems to vary with the HBV prevalence in the general population.

The high prevalence of HBV exposure (47.3%) obtained in the current study is relatively higher than the 19% obtained by Tasilong *et al* in Yaoundé (the capital of Cameroon) in 2016 (9). This difference in prevalence could be because of the difference in the diagnostic technique used, given that Tasilong *et al* worked with the one-step, rapid strip test which has a relatively lower sensitivity and specificity when compared to the ELISA technique used in this study (16–19). The high rate of HBV exposure among HCWs in this study may be related to the low level of knowledge on the route of HBV transmission among HCWs in this population recently estimated to be 67.6% (8).

The prevalence of HBV infection obtained in this study (10.6%) was higher than the 8.75% obtained by Ndongo *et al*. in their national survey among HCWs in Cameroon (7). The difference in prevalence could be justified by the fact that the national survey focused on the regional hospital (which represents the government reference hospital in this region) and the difference in the technique used (rapid strip test). A similar study carried out in a local hospital in Yaoundé reported a comparable prevalence among HCWs [11%) (9) while Loriette *et al*., working in the Extreme Nord Region of Cameroon recorded a prevalence of 18% (15). This alternating prevalence, could be a reflection of the cultural and climatic differences existing between the different ethnic groups alongside the diverse geographical scenery of the country (7).

Prevalence of exposure and natural immunity were significantly associated and seem to increase with age. In effect, it is known that the clinical course and outcome of HBV infection is greatly influenced by age at infection, the level of HBV replication and the host immune status (20). According to Ott J. *et al*., the decrease in exposure with age could be explained by the expanded immunization between 1990 to 2005 which led to a decrease in HBV infections in most regions particularly Central sub-Saharan Africa (21). Furthermore, risk of transmission might have changed over time due to increased awareness and precautions like wearing of gloves, frequent hand washing and use of safety needles.

The prevalence of infectivity was 2.5% for all the HCWs and 23% for HBV infected HCWs. The persistence of HBeAg in blood is always associated with progress towards a liver disease as well as an increase probability of transmitting the virus. Even though there

exist a management guide proposed by WHO in 2015, this high prevalence of infectivity among infected HCWs could be because of the elevated cost involve in managing the disease (2).

According to the 'CDC updates HBV vaccination guidelines for HCWs' (2014), healthcare personnel should be vaccinated against hepatitis B virus (HBV) before exposure to blood or body fluids and should receive serologic testing to assess for antibody against the virus (22). Still, just 9.1% of HCWs in our setting showed acquired immunity. According to Ndongo *et al.*, auxiliary staff were the least likely to be vaccinated compared to the other HCWs accounting for the low prevalence of acquired immunity among them (7). HCWs belonging to the (16-25) year age group were the most vaccinated. This might be because some institutions now ask for proof of HBV vaccination in none-infected individuals before hire or matriculation. Overall, the low prevalence of HCWs vaccinated against HBV might either be due to inappropriate sensitization on HBV or the cost of the HBV vaccine.

HBV susceptibility in our study was high (43.5%) and was inversely proportional to age. The statistically significant association between age and susceptibility to HBV might be explained by the decrease in childhood and maternal transmission of HBV due to the expanded immunization between 1990 to 2005 explained above (21). Unfortunately, this infant vaccine cannot provide adequate protection in adulthood increasing the number of susceptible HCWs. More so, duration in the hospital increases with age. Thus, the younger HCWs whose duration in healthcare settings is less than that of older HCWs and who still have a longer period to work in this setting have not been exposed to HBV nosocomial risk factors like older HCWs and have a higher risk of eventually getting exposed when compared to older HCWs.

CONCLUSION

This study revealed a considerable burden (10.6% current infection) of HBV infection in the Bamenda health District, North West Region of Cameroon. Among the infected HCWs, 23.8% of them were infective. These infective HCWs are at risk of infecting their patients. Subsidizing management of HBV for HCWs might reduce the prevalence of infective HCWs and consequently the probability of HBV nosocomial infection from HCWs to their patients. Prevalence of HBV vaccination was low (9.1%) while prevalence of exposure

(47.3%) and susceptibility (43.5%) to HBV were high. There is thus a high need for sensitization of HCWs in this area on HBV transmission and prevention. The sensitisation along with an effective and massive vaccination campaign should be carried out in this region not only among HCWs but in the population in general.

DECLARATIONS

Statement of Ethics: Ethical clearance for the study was obtained from the National Ethics Committee of Cameroon (N°2017/02/871/CE/CNERSH/SP). Authorization to carry out research in the NWR was obtained from the regional delegation. Authorizations to access different hospitals were obtained from the directors or the in-charge of the hospitals. Authorization to access health centers was obtained from the District medical officer (DMO) and the chief of centers of the health facilities in this region. Written informed consent was obtained from each participant.

Consent for publication: Not applicable.

Patients and public involvement: Not applicable.

Availability of data and material: Data are available in a public, open access repository (https://doi.org/10.6084/m9.figshare.13503231.v1).

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

Funding: Not applicable.

Authors' contribution: AE and TC designed the study; AE and NRipa performed the experiments; AE drafted the manuscript; TC, NR, AL, KJR and KS were involved in editing the manuscript; AE and KS performed the statistical analysis. All authors read and approved the final manuscript.

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Table 1: Baseline characteristics of the study population

Variables	Frequency (395)	Percentage (100%)
Sex		

Male	125	31.6
Female	270	68.4
Age Intervals		
16-25	166	42.0
26-35	155	39.2
36-45	50	12.7
46-65	24	6.1
Job		
Nurses	224	56.7
Lab Technicians	90	22.8
Medical Doctors	17	4.3
Dentist	15	3.8
Pharmacist	8	2.0
Auxiliary Staff	41	10.4

Data are n(%)

Table 2: Distribution of HBV profile group (n=395)

Variables n(%)		Exposure 187(47.3)			Past Infection 145(36.7)			Vaccination 36(9.1)		
		n (%)	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**
Sex	Male (n=125)	57(45.6)	1		48(38.4)	1		12(9.6)	1	
	Female (n=270)	130(48.1)	1.108 (0.724-1.695)	.637	97(35.9)	0.899 (0.581-1.394)	.635	24(8.9)	0.919 (0.444-1.902)	.819
	p-value	.358			.357			.476		
Age	16-25 (n=166)	60(36.1)	1		46(27.7)	1		16(9.6)	1	
	26-35 (n=155)	79(51.0)	1.836 (1.175-2.870)	**.008**	60(38.7)	1.648 (1.031-2.634)	**.037**	15(9.7)	1.004 (0.479-2.108)	.991
	36-45 (n=50)	32(64.0)	3.141 (1.626-6.068)	**.001**	27(54.0)	3.062 (1.596-5.877)	**.001**	3(6.0)	0.598 (0.167-2.143)	.430
	46-65 (n=24)	16(66.7)	3.533 (1.428-8.741)	**.006**	12(50.0)	2.609 (1.094-6.223)	**.031**	2(8.3)	0.852 (0.183-3.962)	.838
	p-value	**<.001**			**.003**			.869		
Job	Dentist (n=15)	4(26.7)	1		2(13.3)	1		4(26.7)	1	
	Lab Technicians (n=90)	35(38.9)	1.750 (0.516-5.929)	.369	27(30.0)	2.786 (0.588-13.197)	.197	11(12.2)	0.383 (0.104-1.414)	.150
	Medical Doctors (n=17)	8(47.1)	2.444 (.552-10.833)	.239	7(41.2)	4.550 (0.771-26.835)	.094	2(11.8)	0.367 (0.057-2.372)	.292
	Nurse (n=224)	116(51.8)	2.954 (0.913-9.555)	.071	88(39.3)	4.206 (0.927-19.090)	.063	15(6.7)	0.197 (0.056-0.695)	**.012**
	Pharmacist (n=8)	3(37.5)	1.650	.592	2(25.0)	2.167	.488	2(25.0)	0.917	.931

			(0.264-10.313)			(0.244-19.276)			(0.128-6.556)	
	Auxiliary Staff (n=41)	21(51.2)	2.887 (0.789-10.573)	.109	19(46.3)	5.614 (1.122-28.092)	**.036**	2(4.9)	0.141 (0.023-0.874)	**.035**
	p-value	.187			.147			**.039**		

Data are n(%); p-value<.05 is considered significant; OR: odd ratio.

Table 3: Distribution of HBV profile group (n=395)

Variables n(%)		Current Infection 42(10.6)			Infectivity 10(2.5)			Susceptibility 172(43.5)		
		n (%)	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**
Sex	Male (n=125)	9(7.2)	1		2(1.6)	1		56(44.8)	1	
	Female (n=270)	33(12.2)	1.795 (0.831-3.875)	.136	8(3.0)	1.878 (0.393-8.974)	.430	116(43.0)	0.928 (0.606-1.422)	.732
	p-value	.089			.337			.407		
Age	16-25 (n=166)	14(8.4)	1		4(2.4)	1		90(54.2)	1	
	26-35 (n=155)	19(12.3)	1.517 (0.732-3.141)	.262	3(1.9)	0.799 (0.176-3.630)	.772	61(39.4)	0.548 (0.352-0.854)	**.008**
	36-45 (n=50)	5(10.0)	1.206 (0.412-3.531)	.732	1(2.0)	0.827 (0.090-7.568)	.866	15(30.0)	0.362 (0.184-0.713)	**.003**
	46-65 (n=24)	4(16.7)	2.171 (0.651-7.246)	.207	2(8.3)	3.682 (0.637-21.290)	.145	6(25.0)	0.281 (0.106-0.745)	**.011**
	p-value	.529			.313			**<.001**		
Job	Dentist (n=15)	2(13.3)	1		0(0.0)	-		7(46.7)	1	

	Lab Technicians (n=90)	8(8.9)	0.634 (0.121-3.323)	.590	0(0.0)	-		44(48.9)	1.093 (0.366-3.269)	.873
	Medical Doctors (n=17)	1(5.9)	0.406 (0.033-4.997)	.482	1(5.9)	2.500 (0.147-42.440)	.526	7(41.2)	0.800 (0.197-3.246)	.755
	Nurse (n=224)	28(12.5)	0.929 (0.199-4.333)	.925	7(3.1)	1.290 (0.155-10.774)	.814	93(41.5)	0.811 (0.284-2.315)	.696
	Pharmacist (n=8)	1(12.5)	0.929 (0.071-12.136)	.955	1(12.5)	5.714 (0.319-102.386)	.236	3(37.5)	0.686 (0.119-3.963)	.673
	Auxiliary Staff (n=41)	2(4.9)	0.333 (0.043-2.610)	.295	1(2.4)	1		18(43.9)	0.894 (0.273-2.932)	.854
	p-value	.687			.217			.896		

Data are n(%); p-value<.05 is considered significant; OR: odd ratio.

STROBE (Strengthening The Reporting of OBservational Studies in Epidemiology) Checklist

A checklist of items that should be included in reports of observational studies. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Section and Item	Item No.	Recommendation	Reported on Page No.
Title and Abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/Rationale	2	Explain the scientific background and rationale for the investigation being reported	
Objectives	3	State specific objectives, including any prespecified hypotheses	
Methods			
Study Design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	

Section and Item	Item No.	Recommendation	Reported on Page No.
Data Sources/ Measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	
Study Size	10	Explain how the study size was arrived at	
Quantitative Variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical Methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive Data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome Data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	

Section and Item	Item No.	Recommendation	Reported on Page No.
Main Results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other Analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key Results	18	Summarise key results with reference to study objectives	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Cross-sectional hospital based-study on the sero-prevalence of Hepatitis B virus markers among health care workers, NWR, Cameroon.

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Cross-sectional hospital based-study on the sero-prevalence of Hepatitis B virus markers among health care workers, NWR, Cameroon.

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Abstract

Background: Hepatitis B virus (HBV) infection is a major public health issue worldwide, with about 257 million people reported to be chronic carriers by the World Health Organization factsheet updated in 2018. HBV can be contracted via direct contact with infected body fluid and infection is almost always asymptomatic. Although healthcare workers (HCWs) are at high risk of HBV infection, little is known about the prevalence of the various HBV markers among HCWs in Cameroon. The present study was taken to evaluate the prevalence of different HBV serological markers among HCWs in the North-West Region of Cameroon.

Methods: This cross-sectional hospital based study was carried out between April to September (2017) during which 395 HCWs were recruited. The serum of the HCWs were tested for the presence of HBV core antibody (anti-HBc), Hepatitis B surface antibody (anti-HBs), Hepatitis B e antibody (anti-HBe) and Hepatitis B surface antigen (HBsAg) using Monalisa™ ELISA kits produced by BIO-RAD laboratories. Data was analysed using SPSS version 20.0.

Results: Among the 395 participants, 270 (68.4%) of them were females, 187 (47.3%) had been exposed to HBV, 145 (36.7%) had resolved the infection, 42 (10.6%) were current HBV carriers, 10 (2.5%) were infective, 36 (9.1%) were vaccinated and 172 (43.5%) were still susceptible. Exposure to HBV, past infection and susceptibility were significantly associated with age while the rate of vaccination was significantly associated with the job of the HCW in the health facilities.

Conclusion: The prevalence of HBV exposure and infection among HCWs obtained in this study was high while the level of vaccination in this at-risk population was low. Adequate steps should be taken to sensitize this population on HBV and the vaccination procedure.

Keys words: Hepatitis B Virus, Healthcare Workers, HBsAg, Anti-HBs, Anti-HBc, Anti-HBe.

Abbreviations: anti-HBc: hepatitis B core antibody, anti-HBs: Hepatitis B surface antibody, anti-HBe: HBV e antibody, HBsAg: Hepatitis B surface antigen, MD: Medical doctor, Lab tech: Laboratory technician, HCWs: Health care workers, SRN/SRM: State Registered Nurse/Midwife, NWR: North West Region, HND: Higher National Diploma, BSc: Bachelor of Science, HBsAg: Hepatitis B surface antigen, ELISA: Enzyme-linked immunosorbent assay, CMA: Centre medical d'arrondisement (district medical centres).

Strength:

- Monalisa™ ULTRA ELISA kits with 100% sensitivity and specificity of 99.28% was used to determine HBV serological markers.
- Stratified sampling technique, which permits estimation of population parameters for groups within population was used for sampling.

Limitation:

- The anti-HBs titer was not quantified thus the percentage of HCWs considered to be vaccinated in this study is higher than the actual percentage with a protective level of anti-HBs..
- Liver biopsy was not done to prove the complete clearance of the virus in resolved infection and serum HBV DNA was not measured since there is no kit available yet to determine this marker.
- The present study covers a cross-section of health professionals, so caution should be taken while generalizing the results.

INTRODUCTION

Hepatitis B virus infection is a viral infection that attacks the liver and can cause both acute, self-resolving, and chronic disease (1). The Hepatitis B virus (HBV), made of a partially double stranded DNA belongs to the family of Hepadnaviridae. This virus found in both blood and body fluids of infected persons, can be transmitted to the mucus membrane or blood stream of non-infected persons (1). According to the WHO fact sheet updated in July 2018, an estimated 257 million people are infected with HBV worldwide and more than 887,000 people died in 2015 due to complications of HBV including cirrhosis and hepatocellular carcinoma (2). The level of HBV varies widely across WHO regions with the WHO African and WHO Western Pacific Region sharing the greatest burden (6.1% and 6.2% of the population respectively). In Cameroon, a sub-Saharan African country, HBV infection is considered hyper-endemic with a prevalence rate estimated at 11.5% (3).

HBV infection is preventable with the presence of a vaccine which confers over 96% protection to recipients (4,5). In Cameroon, the HBV vaccine (Zilbrix™, a DTPw-HBV combination vaccine) was first introduced into the expanded immunization program (EPI) administered to babies at 6 weeks, 10 weeks and 14 weeks (6). The monovalent birth dose implemented in 2017 is limited to babies born of HBV positive mothers. This vaccine administered during early childhood can only provide some level of protection during early adulthood (5–7).

Health-care workers (HCWs) whose job is to care for the sick and injured are often exposed to blood and other body fluids in the course of their work. Consequently, they are at increased risk of infection with blood borne viruses such as Human Immunodeficiency virus (HIV), HBV and Hepatitis C Virus (8). The risk of infection for health workers depend on the prevalence of the disease in the patient population and the nature and the frequency of exposures (9). HCWs when infected, are at risk of transmitting HBV to their patients (9). Because of the risk associated with their occupation, WHO recommends that all non-infected health care workers be vaccinated against HBV (8).

A national survey in Cameroon on the prevalence of HBV among HCWs reported a national sero-prevalence of 8.75% current infection (10) while a recent study carried out among HCWs in this region reported a prevalence of 10.6% (11). Very little work has been done on the various HBV serological markers (anti-HBC, anti-HBs, anti-HBe and HBeAg) to evaluate exposure, natural immunity (past or resolved infection), infectivity, vaccination (acquired immunity) and susceptibility (12,13). In this study, we therefore set out to evaluate the different serological markers associated with HBV infection (anti-HBc, anti-HBs, HBsAg and anti-HBe). These serological markers were used to evaluate the prevalence of exposure, natural immunity, current infection, infectivity, acquired immunity and susceptibility to HBV among HCWs in our setting. Knowledge on these HBV epidemiological features can assist in the development of specific programs such as vaccination campaigns for susceptible HCWs and guide health policy makers in prioritizing and optimizing treatment of infected and/or infective HCWs. This in turn can help public health surveillance institutions in our resource-limited setting to optimize the available resources.

MATERIALS AND METHODS

Study design and setting

This was a cross-sectional hospital-based study conducted between April and September 2017. The study included 22 health facilities in the Bamenda health district (one regional hospital, three CMAs (Centre medical d'arrondissement), six mission hospitals, five government health centres and seven private hospitals). Testing stations were set up in the various wards of the health facilities. Over 70% of HCWs in the various health facilities were recruited for this study.

Case definition

In this study, exposure was defined as being tested positive for the anti-HBc only, natural immunity (past/resolved infection) was being tested positive for anti-HBc and anti-HBs, current infection was defined as being tested positive for HBsAg, infective subjects were those who were tested positive for HBsAg and negative for anti-HBe, vaccinated subjects were those who were tested positive for anti-HBs only while susceptible (naïve) subjects were those who were negative for all HBV serological markers. Being tested positive implies they were reactive for the marker of interest.

Sample size and justification

Sample size was determined using the formula proposed by Scott Smith for determining population proportion sample size (14): X=Z-score × SD × (1−SD)/MOE. The proportion of HCWs in the NWR was obtained from a registry which published the national proportions of HCWs per region in 2015 (15). The confidence level was 95%, giving a Z-score of 1.96, a margin of error (MOE) of ±5 and an SD of 0.5. The calculated sample size using this formula was 385 persons.

Sample collection

All HCWs present in the Bamenda Health District (BHD) during the study were invited to participate in this study. HCWs who consented to the study were asked to sign a consent form, fill a self-administered questionnaire after which 4ml of blood was collected from them into a red cap (dry) tube. Identification number was used to link participant's laboratory results and the questionnaire. A standardized questionnaire designed by the researcher was used to collect socio-demographic data and HCWs category. HCWs included medical doctors, nurses, laboratory technicians, dentist, pharmacist and hospital auxiliary staff (cleaners, carriers, launders).

HBV serology

Monalisa™ ELISA kits produced by BIO-RAD laboratories with sensitivity and specificity greater than 99% were used to qualitatively determine the different HBV serological markers. Monolisa™ HBsAg ULTRA ELISA kit was used to test for the presence of HBsAg, Monolisa™ Anti-HBs PLUS ELISA kit (BIORAD, Marnes- La-Coquette-France), was used to test for the presence of anti-HBs, Monolisa™ Anti-HBc PLUS ELISA kit was used to test for the presence of anti-HBc while Monolisa™ HBe Ag-Ab PLUS ELISA kit (BIORAD, Marnes- La-Coquette-France) was used to test for the presence of anti-HBe.

Statistical analysis

Statistical analysis was performed using the Statistical software IBM@ SPSS@ Statistics Version 22.0 for mac. Continuous data were expressed as median values with 1st and 3rd interquartile ranges (IQR). Categorical data were expressed as percentages. Pearson's $\chi 2$ ($p<.05$) was used to assess the significance among study variables. Odd ratio was

calculated using binary logistic regression. Odd ratio was calculated using binary logistic regression.

RESULTS

Characteristics of study population

A total of 395 health care workers (HCWs) from the different hospitals in this region participated in the study. Among these, 68.4% (n=270) were women (

Table *1*). The 16 to 25 years old age group represented 42.0% (n=166) of the study population. The median age of the study population was 27.0 years (IQR, 23 - 32 years). Nurses were the most represented in the HCWs category, (n=224, 56.3%).

Exposure to HBV

Anti-HBc was used to determine exposure to HBV (Table 2). Of the 395 health care workers who participated in this study, 187 (47.3%) were tested positive for anti-HBc. A statistically significant association was observed between exposure and age (p-value<.001). Exposure to HBV significantly increased with age and HCWs belonging to the (46-65) years age group had a greater than 3.5 times probability of being exposed to HBV when compared to those belonging to the (16-25) years age group. There was no significant association between sex, HCWs category and exposure. However, exposure was relatively lower among dentist (n=4, 26.7%) than among other HCWs. Prevalence of exposure was similar between sexes.

Natural immunity against HBV (HBV clearance)

A combination of anti-HBc and anti-HBs was used to evaluate natural immunity against HBV (past/resolved infection) (Table 2). One hundred and forty-five (77.5%) HCWs who had come in contact with HBV had effectively cleared the virus. Natural immunity was significantly associated with age (p-value<.05), and was highest in the (36-45) year age group (n=27, 54.0%). HCWs belonging to the (36-45) year age group showed a 3 times significantly greater probability of resolving the infection when compared to HCWs belonging to the (16-25) year age group. There was no significant correlation between ability to clear the hepatitis B virus, sex and HCWs category.

Current HBV infection

The presence of HBsAg was used to determine current HBV infection (Table 3). HBsAg was detected in 42 of the 395 HCWs (10.6%). There was no statistically significant association between sex, age, HCWs category and current infection. HBsAg infection was higher among females (n=33, 12.2%; 1.795, 95%CI [0.831-3.875])) than among males (n=9, 7.2%). Majority of HBsAg infected HCWs belonged to the (46-65) year age group (n=4, 16.7%) and were dentist (n=2, 13.3%).

HBV infectivity among HCWs

The presence of HBsAg and the absence of anti-HBe were used to evaluate HBV infectivity (Table 3). Among the 10.4% of HCWs infected with HBV, 23.8% (n=10) of them and 2.5% of all the HCWs in this study were infective. There was no significant association between sex, age, job and being HBV infective. More females were infective (n=8, 3.0%) compared to males (n=2, 1.6%). The (46-65) year age group recorded the highest prevalence of infective HCWs (n=2, 8.3%) and were pharmacist (n=1, 12.5%).

Acquired immunity (vaccinated) HCWs

The absence of anti-HBc and the presence of anti-HBs were used to determine vaccinated HCWs (Table 2). Among the 208 HCWs who had never been exposed to HBV, 17.3% (n=36) of them and 9.1% of the 395 study participants were vaccinated. There was a statistically significant association between being vaccinated and HCWs category (p-value<.05). Nurses (n=15, 6.7%; 0.197, 95%CI[0.056-0.695], p-value=.012) and auxiliary staff (2, 4.9%; 0.141, 95%CI[0.023-0.874], p-value=.036) had a significantly lower probability of being vaccinated when compared to dentist. Males and females had a similar prevalence of acquired immunity (12 [9.6%] males and 24 [8.9%] females). Most of those vaccinated belonged to the (26-35) year age group (n=15, 9.7%) and were dentist (n=4, 26.7%). There was no significant association between acquired immunity, sex and job.

Susceptible HCWs

Susceptibility was determined by the absence of anti-HBc, anti-HBs and HBsAg in serum (Table 3). Among the 395 HCWs who participated in this study, 43.5% (n=172) of them were still susceptible to HBV. A statistically significant association was observed between age and susceptibility (p-value<.001). Susceptibility significantly decreased with age and was highest in the (16-25) year age group (n=90, 54.2%). There was no significant association between susceptibility, sex and HCWs category.

DISCUSSION

Hepatitis B virus is a major cause of Chronic Hepatitis, Liver Cirrhosis and Hepatocellular Carcinoma. As a viral infection, which can be transmitted via percutaneous and mucosal exposure to infective body fluids, HBV stands as a serious nosocomial infection in health

care settings. The current study aimed at evaluating the sero-prevalence of the different HBV serological profiles among HCWs in the NWR of Cameroon showed a high HBV burden in this population. A number of epidemiological and cross-sectional studies have reported marked variation in the prevalence of the various HBV serological profiles among HCWs within and out of the country (10–13,16–18). HBV prevalence in this at-risk group seems to vary with the HBV prevalence in the general population.

Exposure to HBV

The prevalence of HBV exposure obtained in the current study was high (47.3%) and significantly associated with age. This rate of exposure is relatively higher than the 19% obtained by Tasilong *et al* in Yaoundé (the capital of Cameroon) in 2016 (12). The difference in prevalence could be because of the difference in the diagnostic technique used, given that Tasilong *et al* worked with the one-step, rapid strip test which has a relatively lower sensitivity and specificity when compared to the ELISA technique used in this study (19–22). Besides, the distribution of the HBV vaccine in the expanded immunization program (EPI), administered to babies was first introduced in Yaoundé and subsequently to other regions (6). This HBV childhood vaccine has been proposed to provide some level of protection against HBV during early adulthood (protection which wanes as you grow older) and might justify the increase in the rate of HBV exposure with age (5–7,23). Finally, older HCWs have spent a longer time in the hospital compared to the younger HCWs most of who are starting in the field.

Natural immunity against HBV (HBV clearance)

The prevalence of acquired immunity among HCWs exposed to HBV was high and was significantly associated with age. In effect, it is known that the clinical course and outcome of HBV infection is greatly influenced by the age at infection, the level of HBV replication and the host immune status (24). This might justify the relatively low level of resolved infection in the 16-25 years age group (27.5%) which increased up to the 36-45 years age group (54.0%) and finally dropped in the 46-65 years age group (50%). However, the prevalence of natural immunity was comparable between the sexes eventhough males had a lower probability of resolving the infection when compared to females. The similarity in prevalence of natural immunity is contrary to what is anticipated given that women generally show a stronger innate and adaptive (humoral

and cellular) immune responses when compared to males (25). This similarity in prevalence of natural immunity may be justified by the fact that in countries with high prevalence of HBV, exposure to HBV often occurs during birth and early childhood, and infection may progress for 20 to 25 years in a subtle manner as stated above. The expanded immunization program evoked earlier might have reduced the level of exposure to HBV during childhood justifying the seemingly high prevalence of HBV acquired immunity among those exposed to HBV. The reason why this disease is self-limiting in some people and not in others have not yet been fully understood. However, it is believed that the host's immune system and the genome of the infecting HBV might play an important role in determining the outcome of the disease in healthy adults.

Current HBV infection

The prevalence of HBV infection obtained in this study was high (10.6%) given that they exist a safe and competent vaccine. The prevalence of HBsAg positivity is higher than the 8.75% obtained by Ndongo *et al*. in the NWR in their national survey among HCWs in Cameroon (10). The difference in prevalence could be justified by the fact that the national survey focused on the regional hospital (which represents the government reference hospital in this region) and used a different technique (rapid strip test). The same study mentioned above reported a prevalence of 5.4% in Yaoundé and 24% in the Far North Region, while Loriette *et al*., working in the Far North Region of Cameroon recorded a prevalence of 18% in 2015 (10,18). This alternating prevalence, could be a reflection of the cultural and climatic differences existing between the different ethnic groups alongside the diverse geographical scenery of the country (10).

HBV infectivity among HCWs

HBeAg is a serological marker that indicates the presence of HBV DNA in blood circulation in wild-type HBV. As the immune system clears HBV DNA, HBeAg reduces in the blood circulation as anti-HBe appears (26,27). Mutations in some cases can result in HBV DNA being present in blood circulation in the absence of HBeAg (26,27). However, because there is no ELISA kit to determine the presence of HBV DNA in serum, we defined infectivity as the presence of HBsAg and absence of anti-HBe. This classification of infectivity is the best classification using the ELISA kits but is a limitation to the study given that some infected HCWs can go undetected. Among the 10.4% of HCWs infected

with HBV, 23.8% of them were infective. The persistence of HBeAg in blood is always associated with progress towards a liver disease as well as an increase probability of transmitting the virus. Even though there exist a management guide proposed by WHO in 2015, this high prevalence of infectivity among infected HCWs might be because of the elevated cost involve in managing the disease (9,28).

Acquired immunity (vaccinated) HCWs

According to the 'CDC updates HBV vaccination guidelines for HCWs' (2014), healthcare personnel should be vaccinated against HBV before exposure to blood or body fluids and should receive serologic testing to assess for anti-HBs (29). Still, just 9.1% of HCWs in our setting showed acquired immunity. HCWs belonging to the (16-25) year age group were the most vaccinated. This might be because of the expanded immunization invoked earlier (6,7,23). But most probable is the fact that some institutions now ask for proof of HBV vaccination in none-infected individuals before hire or matriculation. Overall, the low prevalence of HCWs vaccinated against HBV might either be due to inappropriate sensitization on HBV or the cost of the HBV vaccine.

Susceptible HCWs

HBV susceptibility in our study was high (43.5%) and was inversely proportional to age. The statistically significant association between age and susceptibility to HBV might be explained by the decrease in childhood and maternal transmission of HBV due to the expanded immunization explained above (6,7,23). Unfortunately, this infant vaccine cannot provide adequate protection in adulthood and most parents never go for the booster dose because of the cost of the vaccine reducing childhood HBV transmission but increasing the number of susceptible adult HCWs. More so, duration in the hospital increases with age. Thus, the younger HCWs whose duration in healthcare settings is less than that of older HCWs and who still have a longer period to work in this setting have not been exposed to HBV nosocomial risk factors like older HCWs and have a higher risk of eventually getting exposed when compared to older HCWs.

CONCLUSION

This study revealed a considerable burden (10.6% current infection) of HBV infection in the Bamenda health District, North West Region of Cameroon. Among the infected HCWs,

over 23.8% of them were infective. These infective HCWs are at risk of infecting their patients. Subsidizing management of HBV for HCWs might reduce the prevalence of infective HCWs and consequently the probability of HBV nosocomial infection from HCWs to their patients. Prevalence of HBV vaccination was low (9.1%) while prevalence of exposure (47.3%) and susceptibility (43.5%) to HBV were high. There is thus a high need for sensitization of HCWs in this area on HBV transmission and prevention. The sensitisation along with an effective and massive vaccination campaign should be carried out in this region not only among HCWs but in the population in general.

DECLARATIONS

Statement of Ethics: Ethical clearance for the study was obtained from the National Ethics Committee of Cameroon (N°2017/02/871/CE/CNERSH/SP). Authorization to carry out research in the NWR was obtained from the regional delegation. Authorizations to access different hospitals were obtained from the directors or the in-charge of the hospitals. Authorization to access health centers was obtained from the District medical officer (DMO) and the chief of centers of the health facilities in this region. Written informed consent was obtained from each participant.

Consent for publication: Not applicable.

Patients and public involvement: No patient involve.

Availability of data and material: Data are available in a public, open access repository (https://doi.org/10.6084/m9.figshare.13503231.v1).

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

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Authors' contribution: AE and TC designed the study; AE and NRipa performed the experiments; AE drafted the manuscript; TC, NR, AL, KJR and KS were involved in editing

the manuscript; AE and KS performed the statistical analysis. All authors read and approved the final manuscript.

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Table 1: Baseline characteristics of the study population

Variables	Frequency (395)	Percentage (100%)
Sex		
Male	125	31.6
Female	270	68.4
Age Intervals		
16-25	166	42.0
26-35	155	39.2
36-45	50	12.7
46-65	24	6.1
Job		
Nurses	224	56.7
Lab Technicians	90	22.8
Medical Doctors	17	4.3
Dentist	15	3.8
Pharmacist	8	2.0
Auxiliary Staff	41	10.4

Data are n(%)

Table 2: Distribution of HBV profile group (n=395)

Variables n(%)		Exposure 187(47.3)			Past Infection 145(36.7)			Vaccination 36(9.1)		
		n (%)	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**
Sex	Male (n=125)	57(45.6)	1		48(38.4)	1		12(9.6)	1	
	Female (n=270)	130(48.1)	1.108 (0.724-1.695)	.637	97(35.9)	0.899 (0.581-1.394)	.635	24(8.9)	0.919 (0.444-1.902)	.819
	p-value	.358			.357			.476		
Age	16-25 (n=166)	60(36.1)	1		46(27.7)	1		16(9.6)	1	
	26-35 (n=155)	79(51.0)	1.836 (1.175-2.870)	**.008**	60(38.7)	1.648 (1.031-2.634)	**.037**	15(9.7)	1.004 (0.479-2.108)	.991
	36-45 (n=50)	32(64.0)	3.141 (1.626-6.068)	**.001**	27(54.0)	3.062 (1.596-5.877)	**.001**	3(6.0)	0.598 (0.167-2.143)	.430
	46-65 (n=24)	16(66.7)	3.533 (1.428-8.741)	**.006**	12(50.0)	2.609 (1.094-6.223)	**.031**	2(8.3)	0.852 (0.183-3.962)	.838
	p-value	**<.001**			**.003**			.869		
Job	Dentist (n=15)	4(26.7)	1		2(13.3)	1		4(26.7)	1	
	Lab Technicians (n=90)	35(38.9)	1.750 (0.516-5.929)	.369	27(30.0)	2.786 (0.588-13.197)	.197	11(12.2)	0.383 (0.104-1.414)	.150
	Medical Doctors (n=17)	8(47.1)	2.444 (.552-10.833)	.239	7(41.2)	4.550 (0.771-26.835)	.094	2(11.8)	0.367 (0.057-2.372)	.292
	Nurse (n=224)	116(51.8)	2.954 (0.913-9.555)	.071	88(39.3)	4.206 (0.927-19.090)	.063	15(6.7)	0.197 (0.056-0.695)	**.012**
	Pharmacist (n=8)	3(37.5)	1.650	.592	2(25.0)	2.167	.488	2(25.0)	0.917	.931

			(0.264-10.313)			(0.244-19.276)			(0.128-6.556)	
	Auxiliary Staff (n=41)	21(51.2)	2.887 (0.789-10.573)	.109	19(46.3)	5.614 (1.122-28.092)	**.036**	2(4.9)	0.141 (0.023-0.874)	**.035**
	p-value	.187			.147			**.039**		

Data are n(%); p-value<.05 is considered significant; OR: odd ratio.

Table 3: Distribution of HBV profile group (n=395)

Variables n(%)		Current Infection 42(10.6)			Infectivity 10(2.5)			Susceptibility 172(43.5)		
		n (%)	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**	**n (%)**	**OR (95% CI)**	**P[b]**
Sex	Male (n=125)	9(7.2)	1		2(1.6)	1		56(44.8)	1	
	Female (n=270)	33(12.2)	1.795 (0.831-3.875)	.136	8(3.0)	1.878 (0.393-8.974)	.430	116(43.0)	0.928 (0.606-1.422)	.732
	p-value	.089			.337			.407		
Age	16-25 (n=166)	14(8.4)	1		4(2.4)	1		90(54.2)	1	
	26-35 (n=155)	19(12.3)	1.517 (0.732-3.141)	.262	3(1.9)	0.799 (0.176-3.630)	.772	61(39.4)	0.548 (0.352-0.854)	**.008**
	36-45 (n=50)	5(10.0)	1.206 (0.412-3.531)	.732	1(2.0)	0.827 (0.090-7.568)	.866	15(30.0)	0.362 (0.184-0.713)	**.003**
	46-65 (n=24)	4(16.7)	2.171 (0.651-7.246)	.207	2(8.3)	3.682 (0.637-21.290)	.145	6(25.0)	0.281 (0.106-0.745)	**.011**
	p-value	.529			.313			**<.001**		
Job	Dentist (n=15)	2(13.3)	1		0(0.0)	-		7(46.7)	1	

	Lab Technicians (n=90)	8(8.9)	0.634 (0.121-3.323)	.590	0(0.0)	-		44(48.9)	1.093 (0.366-3.269)	.873
	Medical Doctors (n=17)	1(5.9)	0.406 (0.033-4.997)	.482	1(5.9)	2.500 (0.147-42.440)	.526	7(41.2)	0.800 (0.197-3.246)	.755
	Nurse (n=224)	28(12.5)	0.929 (0.199-4.333)	.925	7(3.1)	1.290 (0.155-10.774)	.814	93(41.5)	0.811 (0.284-2.315)	.696
	Pharmacist (n=8)	1(12.5)	0.929 (0.071-12.136)	.955	1(12.5)	5.714 (0.319-102.386)	.236	3(37.5)	0.686 (0.119-3.963)	.673
	Auxiliary Staff (n=41)	2(4.9)	0.333 (0.043-2.610)	.295	1(2.4)	1		18(43.9)	0.894 (0.273-2.932)	.854
	p-value	.687			.217			.896		

Data are n(%); p-value<.05 is considered significant; OR: odd ratio.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	5-6
		(*c*) Explain how missing data were addressed	6
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6
		(*e*) Describe any sensitivity analyses	6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	7-8
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	7-8

		(*b*) Report category boundaries when continuous variables were categorized	7-8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	7-9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9-12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	8-12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.