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Uptake of Cost-Free Hepatitis B Vaccination among Healthcare Workers in Northern Tanzania

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Abstract

Background
The World Health Organization (WHO) and other global agencies recommend all healthcare workers (HCWs) to get vaccinated against hepatitis B virus before enrolment to clinical work. There are limited data in low-income countries on hepatitis B virus vaccination coverage among HCWs, which set back WHO Hepatitis B Elimination Strategy 2016-2021. The aim of this study was to determine the prevalence of hepatitis B virus vaccination uptake and associated factors among HCWs from a tertiary and teaching hospital in northern Tanzania.

Methods
A cross-sectional study was conducted among HCWs at Kilimanjaro Christian Medical Centre (KCMC) a referral and teaching hospital from August 2016 to June 2017. Questionnaire based interviews were used to obtain information about HCWs' demographic characteristics, occupation risks and other invasive procedures such as intravenous, and intramuscular injections and knowledge of Hepatitis B Virus (HBV) infection. Multivariable logistic regression was used to determine factors associated with Engerex DNA-recombinant hepatitis B vaccine uptake.

Results
About two third 295 (67.4%) of 438 participants had received HBV vaccination. Among those who ever received HBV vaccination (n=295), 205 (70.5%) received 3 shots, 57 (19.5%) received 2 shots and 33 (10%) received 1 shot. HCWs working in clinical areas had 79% higher odds of vaccine uptake compared to those who were not (OR=1.79, 95%CI 1.11, 2.89). Ever having intravenous and intramuscular injections significantly increased the odds of vaccination uptake compared to those who never had (OR=2.21, 95%CI 1.33, 3.66) and (OR=2.42, 95%CI 1.36, 4.28) respectively. Also, HCWs with a fair and good knowledge on HBV infection had over three times higher odds of vaccine uptake compared to those with poor knowledge (OR=3.08, 95%CI 1.90, 5.01) and (OR=3.07, 95%CI 1.75, 5.40), respectively. After adjusting for other factors, those that remained to be significantly associated with HBV vaccine uptake were area of specialty and knowledge on HBV infection.

Conclusion
The current Engerex DNA-recombinant hepatitis B vaccine coverage among HCWs at KCMC, referral and teaching hospital in North-eastern Tanzania was only 67.4% despite of it been given free of charge. Factors that were associated with HBV vaccine uptake include area of specialty and knowledge of participants on HBV infection and vaccination. We encourage continuous medical education among HCWs about importance of hepatitis B vaccination. We also recommend hepatitis B vaccination as pre-employment requirement for HCWs as well as doing antibody titer determination post vaccination.

Keywords: *Cost-free hepatitis B vaccine, Prevention, Healthcare workers, vaccination coverage, Low-income countries, Tanzania.*

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Background

Hepatitis B Virus (HBV) is a major causative agent of chronic hepatitis and can cause liver cirrhosis and hepatocellular carcinoma (1). It is among the most serious blood borne pathogens which brings threats to healthcare workers (HCWs) however, it has an effective vaccine which is readily available. Globally there is approximately 250 million people with chronic HBV who remain carriers for new infections (1-2). African and Asian pacific harbours more than 68% of the global carriers and the prevalence of HBV infection has been reported to be more than 8% (3). In East and central Africa prevalence of HBsAg is 8% while in Tanzania it ranged from 10% to 12.5% across different adult population (4). Among Tanzanians paediatrics population there is relatively low prevalence of HBV infection as compared to adult populations that ranges from 1.8% to 4.3% (5). Studies in different countries showed different findings of hepatitis B vaccination uptake among HCWs. Vaccination uptake among HCWs in Sweden, Pakistan, Turkey, France and South Africa showed the uptake was 39.8%, 37.2%, 55.8%, 93% and 19.9% respectively, and HCWs managed to finish three doses of hepatitis B vaccine (6-10).

HCWs are at increased risk of HBV infection because of constant occupational exposure with blood, body fluids, blood products and needle-stick injuries. The incidence of HBV infection among HCWs in South Africa has been estimated to be 2 to 4 folds as compared to the general population (11-12). HBV infection is the vaccine preventable infection where by the current vaccine has been effective and safe for the past two decades. There is evidence of significant decrease of liver diseases including hepatocellular carcinoma in East Asia because of the role of HBV vaccination. Apart from the presence of safe and effective vaccine, WHO reported that HBV vaccination coverage amongst HCWs in low-and middle-income countries is only 18-39% (10, 11). Furthermore, continuous medical education and introduction of HBV among HCWs reduced HBV prevalence from 10% to 1% in Cameroon and South Africa. Also, in the scenarios of exposure to blood and body fluids, the role of post-exposure prophylaxis of hepatitis B vaccination and immunoglobulin administration is an added advantage (13-14). Due to reported different prevalence of hepatitis B vaccination across the globe with limited data from HCWs there is need to look at the factors associated with hepatitis B vaccination uptake. We therefore conducted this study to determine the prevalence of hepatitis B vaccination uptake and factors associated with vaccination uptake among HCWs.

Methods

Design, patients and study procedures

The data collection methods applied in this study are also reported elsewhere by Shao et al (13). Briefly, this was a cross-sectional study conducted from August 2016 to June 2017 at Kilimanjaro Christian Medical Centre (KCMC). KCMC is a referral and teaching hospital which serves over 15 million people in North-eastern Tanzania. The study included HCWs from all departments, including nurses, students on training, medical attendants, laboratory scientists and clinicians from surgical and medical related specialties. Inclusion criterion was healthcare workers who had worked at the institution for more than six months while exclusion criterion was those who did not consent. Consenting participants were asked to fill a self-administered questionnaire designed to capture demographic information and risks associated with hepatitis B uptake. Unique identification number was used to link participant's laboratory results and the questionnaire. The investigator collected complete filled questionnaires through special appointment with the study participants.

The sample size was calculated using the following formula for cross-sectional studies: $n=\{z^2p(1-p)\}/d^2$, where n=minimum sample size required; z=1.96, value based on the standard normal distribution at 95% confidence level; p=the estimated proportion of healthcare workers vaccinated for HBV, which was unknown during the study implementation and was estimated at 50% and d=margin of error which we set at 0.05. Allowing for 15% of non-response, the minimum sample size was estimated to be 450 participants.

Serological analysis for HBV

As also described elsewhere (13), blood samples were obtained through venipuncture from all subjects using sterilized disposable 5 ml syringes and 20-gauge needles by an experienced laboratory technologist, and later tested using Laborex HBsAg rapid test, Milan Italy for positive hepatitis B surface antigen. The detail of results interpretation is described elsewhere by Shao et al (13).

Study variables

The dependent variable was HBV vaccine uptake, which was measured by asking the participants; "have you received the hepatitis B vaccine before?". Those who answered 'Yes', indicated vaccine uptake and 'No' if otherwise. The independent variables included knowledge of the risk factors for HBV infection and history of exposure to potential risk factors. The assessment of the past exposure to potential risk factors for HBV infection was

based on previous literature (13). These included ever having a history of surgery, blood splash to the eyes or mouth, intravenous and intramuscular injections, needle stick injury, invasive procedure such as endoscopy, and history of blood transfusion; both having Yes/No responses. Knowledge on HBV infection was measured using 16-item questions as also reported elsewhere (13). Each correct response, i.e., answered "Yes" was scored one mark while none or don't know scored as zero. The total scores were converted to percentage and grouped as poor (< 50%), fair (50–74%), and good (≥75%) (13-14). Other independent variables were age in years (20-29, 30-39, 40+), sex (male, female), education level (primary, secondary, college/ university), marital status (single, married/ cohabiting, widowed/ divorced), religion (Christian, Muslim), area of residence (rural, urban), department (surgical, non-surgical), work in clinical areas (Yes, No), and years of practice (<5, ≥5).

Statistical analysis

Data analysis was performed using STATA® version 13.1, StataCorp LLC. Numeric variable (participant age) was summarized using median and interquartile range (IQR). Categorical variables were summarized using frequencies and percentages. In descriptive analysis, chi-squared test was used to compare hepatitis B vaccine uptake by participant characteristics. Logistic regression model (Odds ratio and the corresponding 95% confidence intervals) was used to determine factors associated with HBV vaccine uptake among HCWs at KCMC. A cut-off of 5% ($p<0.05$) in the crude/bivariate analysis was used to select variables to be included in the multivariable analysis. Variables with $p<0.05$ in the multivariable analysis were considered statistically associated with HBV vaccine uptake.

Ethics, consent and permissions

Ethically this study was approved by KCMUCo Research and Ethics Review Committee with permission number 916. Written informed consent was obtained from participants before recruitment into the study. Confidentiality and privacy were observed. Special identification number was used to identify and link participant information and not names.

Results

A total of 442 healthcare workers (HCWs) at KCMC referral hospital out of 450 expected participated in this study, a response rate of 98.2%. The median age of participants was 37 years and interquartile range (IQR) of 31-46 years. About 43% were aged above 40 years while 165 (37.3%) were aged between 30-39 years. Over 60% were females and above three quarter (78.5%) had tertiary education (College/ University) level. Majority of HCWs

were from a surgical (43.9%) department. Nurses and Doctors together accounted for more than half of all (Table 1).

Table 1: Background characteristics of study participants (N=442)

Variable	Frequency (n)	Percentage (%)
Age (years)		
Median (IQR)	37	(31, 46)
20-29	88	19.9
30-39	165	37.3
40+	189	42.8
Sex		
Male	166	37.6
Female	276	62.4
Education level		
Primary	27	6.2
Secondary	67	15.3
College/ University	344	78.5
Marital status		
Single	140	31.7
Married/Cohabiting	275	62.2
Widow/Divorced	27	6.1
Religion*		
Christian	378	85.7
Muslim	63	14.3
Area of residence		
Rural	187	42.3
Urban	255	57.7
Department		
Surgical	194	43.9
Non-surgical	129	29.2
Others	119	26.9
Specialty		
Doctor	130	29.4
Nurse	137	31.0
Others	175	39.6
Work in clinical area		
Yes	350	79.2
No	92	20.8
Years of practice*		
<5	91	21.0
≥5	342	79.0

**Frequency do not tally to the total due to missing values*

The estimated proportion of HBV vaccine uptake among 438 HCW who responded to this question was 67.4%. Proportion of HBV vaccine uptake varied significantly by HCWs specialty and department (Table 2), as well as past exposure to intravenous injections, intramuscular injections, blood transfusion, knowledge of HBF infection, and serology status (Table 3).

Table 2: HBV vaccination uptake by background characteristics (N=438)

Variable	Total	Vaccine uptake n (%)		P-value
		No (32.7%)	Yes (67.4%)	
Age (years)				0.31
20-29	88	34 (38.6)	54 (61.4)	
30-39	163	54 (33.1)	109 (66.9)	
40+	187	55 (29.4)	132 (70.6)	
Sex				0.13
Male	162	60 (37.0)	102 (63.0)	
Female	276	83 (30.0)	193 (70.0)	
Education level				0.84
Primary	27	10 (37.0)	17 (63.0)	
Secondary	65	20 (30.8)	45 (29.2)	
Tertiary	342	113 (33.0)	229 (67.0)	
Marital status				0.43
Single	137	50 (36.5)	87 (63.5)	
Married/Cohabiting	274	86 (31.4)	188 (68.6)	
Widow/Divorced	27	7 (25.9)	20 (74.1)	
Religion				0.05
Christian	377	116 (37.8)	261 (69.2)	
Muslim	60	26 (43.3)	34 (56.7)	
Area of residence				0.30
Rural	184	55 (29.9)	129 (70.1)	
Urban	254	88 (34.7)	166 (65.4)	
Department				0.13
Surgical	191	71 (37.2)	120 (62.8)	
Non-surgical	129	34 (26.4)	95 (73.6)	
Others	118	38 (32.2)	80 (67.8)	
Specialty				0.03
Doctor	127	32 (25.2)	95 (74.8)	
Nurse	136	42 (30.9)	94 (69.1)	
Others	175	69 (39.4)	106 (60.6)	
Work in clinical area				0.001
No	90	42 (46.7)	48 (53.3)	
Yes	348	101 (29.0)	247 (71.0)	

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Years of practice*				0.78
<5	91	31 (34.1)	60 (65.9)	
≥5	338	110 (32.5)	228 (67.5)	

Frequencies do not tally to the total due to missing values

Table 3: HBV vaccination uptake by past exposure to potential risk factors (N=438)

Variable	Total	Vaccine uptake n (%)		P-value
		No	Yes	
History of surgery				0.27
No	297	102 (34.3)	195 (65.7)	
Yes	141	41 (29.1)	100 (70.9)	
History of blood splash to the eyes or mouth††				0.31
No	317	108 (34.1)	209 (65.9)	
Yes	121	35 (28.9)	86 (71.1)	
Ever had intravenous injections				0.002
No	75	36 (48.0)	39 (52.0)	
Yes	363	107 (29.5)	256 (70.5)	
Ever had intramuscular injections				0.002
No	55	28 (50.9)	27 (49.1)	
Yes	383	115 (30.0)	268 (70.0)	
History of needle stick injury*				0.18
No	271	95 (35.1)	176 (64.9)	
Yes	166	48 (28.0)	118 (71.1)	
History of invasive procedure such as endoscopy*				0.48
No	397	131 (33.0)	266 (67.0)	
Yes	40	11 (27.5)	29 (72.5)	
Ever had blood transfusion				0.44
No	398	127 (31.9)	271 (68.1)	
Yes	31	12 (38.7)	19 (61.3)	
Knowledge on HBV infection				<0.001
Poor	107	57 (53.3)	50 (46.7)	
Fair	217	57 (26.3)	160 (73.7)	
Good	114	29 (25.4)	85 (74.6)	
HBV infection*				<0.001
Negative	414	124 (30.0)	290 (70.0)	
Positive	21	18 (85.7)	3 (14.3)	

Frequencies do not tally to the total due to missing values

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The factors associated with higher odds of HBV vaccine uptake in the bivariate/ unadjusted analysis were being a doctor (OR=1.93, 95%CI 1.17, 3.19) compared to participants from other professions (e.g. laboratory and administrative staff, working in clinical areas (OR=2.14, 95%CI 1.33, 3.44), history of intravenous injection (OR=2.21, 95%CI 1.33, 3.66), history of intramuscular injection (OR=2.42, 95%CI 1.36, 4.28), fair (OR=3.20, 95%CI 1.97, 5.20) and good (OR=3.34, 95%CI 1.89, 5.89) compared to those with poor knowledge of HBV infection. Positive serology status was associated with significantly lower odds of vaccine uptake (OR=0.07, 95%CI 0.02, 0.25) compared to those who were negative (Table 4).

Table 4: Bivariate analysis for factors associated with HBV vaccine uptake (N=438)

Variable	COR[†] (95%CI)	P-Value	Variable	COR[†] (95%CI)	P-Value
Age (years)			**History of surgery**		
20-29	1.00		No	1.00	
30-39	1.27 (0.74, 2.18)	0.38	Yes	1.28 (0.83, 1.97)	0.27
40+	1.51 (0.89, 2.57)	0.13	**History of blood splash to the eyes or mouth**		
Sex			No	1.00	
Male	1.00		Yes	1.27 (0.80, 2.00)	0.31
Female	1.37 (0.91, 2.06)	0.13	**Ever had intravenous injections**		
Education level			No	1.00	
Primary	1.00		Yes	2.21 (1.33, 3.66)	0.002
Secondary	1.32 (0.52, 3.40)	0.56	**Ever had intramuscular injections**		
College/ University	1.19 (0.53, 2.69)	0.67	No	1.00	
Marital status			Yes	2.42 (1.36, 4.28)	0.002
Single	1.00		**History of needle stick injury**		
Married/ Cohabiting	1.26 (0.82 (1.93)	0.30	No	1.00	

Widow/ Divorced	1.64 (0.65, 4.15)	0.30	Yes	1.33 (0.87, 2.02)	0.19
Religion			**History of invasive procedure**		
Christian	1.00		No	1.00	
Muslim	0.58 (0.33, 1.01)	0.06	Yes	1.30 (0.63, 2.68)	0.48
Area of residence			**Ever had blood transfusion**		
Rural	1.00		No	1.00	
Urban	0.80 (0.53, 1.21)	0.30	Yes	0.74 (0.35, 1.58)	0.44
Department			**Knowledge on HBV infection**		
Surgical	0.80 (0.49, 1.30)	0.38	Poor	1.00	
Non-surgical	1.33 (0.77, 2.30)	0.31	Fair	3.2 (1.97, 5.20)	<0.001
Others	1.00		Good	3.34 (1.89, 5.89)	<0.001
Specialty			**HBV infection**		
Doctor	1.93 (1.17, 3.19)	0.01	Negative	1.00	
Nurse	1.46 (0.91, 2.33)	0.12	Positive	0.07 (0.02, 0.25)	<0.001
Others	1.00				
Work in clinical area					
No	1.00				
Yes	2.14 (1.33, 3.44)	0.002			
Years of practice*					
<5	1.00				
≥5	1.07 (0.66, 1.75)	0.78			

†COR: Crude odds ratio

The multivariable logistic regression model was adjusted for area of specialty, working in clinical areas, history of intramuscular and intravenous injections, HBV knowledge and HBV infection (Table 5). Factors that remained to be independently associated with a higher odds of HBV infection were working in clinical areas (OR=1.74, 95%CI 1.02, 2.98; p=0.04), having fair (OR=2.74, 95%CI 1.60, 4.76; p<0.001) and good knowledge of HBV infection (OR=2.69, 95%CI 1.45, 4.98; p=0.002) compared to those with poor knowledge. HCWs with HBV infection had significantly lower odds of vaccine uptake (OR=0.06, 95%CI 0.02, 0.22; p<0.001).

Table 5: Multivariable analysis for factors associated with HBV vaccine uptake (N=435)

Variable	Total	Vaccine uptake n (%)	aOR* (95%CI)	p-value
Specialty				
Doctor	127	95 (74.8)	1.16 (0.66, 2.05)	0.61
Nurse	136	94 (69.1)	1.34 (0.79, 2.27)	0.28
Others	175	106 (60.6)	1.00	
Work in clinical area				
No	90	48 (53.3)	1.00	
Yes	348	247 (71.0)	1.74 (1.02, 2.98)	0.04
Ever had intravenous injections				
No	75	39 (52.0)	1.00	
Yes	363	256 (70.5)	1.70 (0.90, 3.21)	0.10
Ever had intramuscular injections				
No	55	27 (49.1)	1.00	
Yes	383	268 (70.0)	1.65 (0.80, 3.40)	0.18
Knowledge on HBV infection				
Poor	107	50 (46.7)	1.00	
Fair	217	160 (73.7)	2.74 (1.60, 4.76)	<0.001
Good	114	85 (74.6)	2.69 (1.45, 4.98)	0.002
HBV infection				
Negative	414	290 (70.0)	1.00	
Positive	21	3 (14.3)	0.06 (0.02, 0.22)	<0.001

**Adjusted odds ratio*

Discussion

The uptake of Engerex DNA-recombinant hepatitis B vaccine which was supplied free of charge was 67.4% among studied HCWs. Thirty-three percent remained unvaccinated which is higher than 24% which was described in the review article on protecting HCWs from nosocomial HBV infections in SSA. The other risk factors such as intravenous use, tattooing, and sexual intercourse were assessed and show low percentage contribution compared to nosocomial (17). Many factors for low vaccination uptake given out by participants included area specialty, cost, time and level of knowledge.

Workers from clinical area were more likely to be vaccinated compared to those from none clinical area. The reason for this might be the difference in understanding between the two groups but also the degree of exposure to patient's proximity (18). The current proportion of hepatitis B vaccination uptake was almost similar to the one reported by WHO in Australia and New Zealand which was 77% and 69%, respectively (18). The proportion of vaccination uptake in this study was higher as compared to other studies, 5.4% and 52% among HCWs in Ethiopia and Libya, respectively (20). Our study had far higher uptake as compared to report from many African countries. The higher uptake was due to the intensive sensitization that was done through notice boards, academic and clinical meetings, through heads of departments and coordinators. This study went further to sensitize workers through other gatherings like church services, and one on one discussion in order to improve coverage. The free provision of hepatitis B vaccination in this study was another reason for high uptake which was not the case for other studies (21-23). It is surprising that HCWs are accessible and easily identified but to implement effective vaccination program among this group is a challenge. In this study we learned that many HCWs who did not turn up for vaccination had no reasons to justify their decline for vaccination. The major reason might be the cost of vaccination (23), but our case was different because we have these vaccines for free from Tanzanian ministry responsible for health, hence, cost was not the issue.

Based on the coverage achieved it means that one third of the HCWs at KCMC referral and teaching hospital in Moshi Tanzania are susceptible to hepatitis B infection. The prevalence of needle stick injury reported in this study was 38%. There is poor documentation and reporting of needle stick injury among HCWs both in developed and developing countries (24-26). When report of the needle stick injury is poor and accompanied by low vaccination uptake the population is far away toward elimination of hepatitis B. In our study, majority

(about 70.5%) of those who received vaccination received full dose of three shots while 10% had received one shot. The current prevalence of free of charge vaccine is still low as compared to the WHO expectation of at least 95%. USA has over ambitious goal of reaching HCWs coverage of 98% (27-29). Improvement of knowledge among HCWs and none medical personnel on hepatitis B will lead to increasing precautions as well as vaccination uptakes. Reducing the cost for vaccination or giving it free of charge will increase uptake and will be cost effective rather than treating infected people. Combination of both increasing continuous medical education and availability of vaccination services will lead to good outcomes towards hepatitis B eradication (30-35).

Conclusion

The vaccination coverage among HCWs at Kilimanjaro Christian Medical Centre, referral and teaching hospital in North-eastern Tanzania was 67% despite of it been given free of charge. Factors that were associated with HBV vaccine uptake include area of specialty and knowledge of participants on HBV infection and vaccination. We encourage continuous medical education among HCWs about the importance of hepatitis B vaccination. Focused and targeted program of education should be given to HCWs and other risks groups. We recommend hepatitis B vaccination as pre-employment requirement for HCWs as well as doing antibody titer post vaccination.

Abbreviations

HBsAb	Hepatitis B surface antibody
HBsAg	Hepatitis B surface antigen
HBV	Hepatitis B virus
HCWs	Healthcare workers
KCMC	Kilimanjaro Christian Medical Center
KCMUCo	Kilimanjaro Christian Medical University College
SPSS	Statistical software for the social sciences
WHO	World Health Organization.

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Availability of data materials

The dataset generated and used during the current study is available and may be accessed from the corresponding author upon request.

Authors' contributions

ES, SK and VM conceptualized the study, FL and KK participated in its design and coordination. ES, DG and VM drafted the manuscript. ES, EM and MN collected the data while BM, IBM, SK, BM and ES contributed to the analysis and interpretation of data. IBM wrote the statistical analysis and results sections. All authors have read and approved the final manuscript.

Consent for publication

Not applicable. There are no personal identifiers in the data we are presenting in this manuscript.

Competing interests

All authors declare that they have no competing interests with regard to this publication.

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