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Seroprevalence of *Hepatitis B virus* among some Healthcare Workers in Public Hospitals in Taiz City-Yemen

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الانتشار المصلي لفيروس التهاب الكبد B بين بعض العاملين في مجال الرعاية الصحية في المستشفيات العامة في مدينة تعز – اليمن

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الملخص

فيروس الكبد البائي مشكلة صحية عالمية العاملون في مجال الرعاية الصحية هم الأكثر تعرضا لمخاطر العدوى بفيروس الكبد البائي. هدفت هذه الدراسة إلى تعيين مدى انتشار فيروس الكبد البائي والتعرف على عوامل الخطورة المرتبطة بالعاملين اليمنيين في مجال الرعاية الصحية لدى المستشفيات العامة في مدينة تعز.

شملت الدراسة العاملين في مجال الرعاية الصحية من المستشفيات العامة في مدينة تعز وتم إجراء الدراسة في الفترة من 2021/8/15م إلى الفترة 2021/9/2م، تم عمل استبانة لجمع البيانات الخاصة بالعامل الصحي المشارك تضمنت معلومات اجتماعية ديموغرافية وعوامل الخطورة المرتبطة بالعامل الصحي. تم جمع دم كامل ثم فصل المصل وتم فحص علامات الإصابة (HBsAg and anti-HBc antibodies) بفيروس الكبد بواسطة تقنية الإليزا، وتم تحليل البيانات بالبرنامج الاحصائي SPSS الاصدار رقم 24.

من بين 179 مشاركا أجابوا على الاستبيان أظهرت الدراسة 1.68% من المشاركين مصابين بفيروس الكبد البائي و44.7% من المشاركين تعرضوا للفيروس، وكانت الفئة الأقل عمرا والذكور والعاملين الصحيين لدى مستشفى الثورة العام والقابلات هم الأكثر فئة إصابة بالفيروس والفئة الأكثر عمرا والذكور والعاملين الصحيين لدى مستشفى التعاون ومساعدي الطبيب هم الأكثر فئة تعرضا بالفيروس. وأظهرت الدراسة أن أكثر من ثلثي العاملين غير مطعمين بلقاح الفيروس بنسبة (68.2%). وكل المصابين بفيروس الكبد كانوا غير مطعمين باللقاح. معظم العاملين بمجال الرعاية الصحية تعرضوا للوخز بالإبر وغيرها بنسبة (81.6%) ومعظمهم نتيجة الوخز بالإبر بنسبة 76.5%. وأكثر الفئات تعرضا للوخز هم فنيو المختبرات والممرضات والعاملين الصحيين لدى المستشفى اليمني السويدي.

يجب إعادة تقييم كلا من برنامج التطعيم والسلامة المهنية والتدريب من أجل خفض التعرض والإصابة بالفيروس والتقليل من خطورة التعرض للوخز بالإبر.

الكلمات المفتاحية: انتشار، فيروس الكبد ب، مولد الضد السطحي لفيروس الكبد ب، العاملين في مجال الرعاية الصحية.

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Abstract:

Hepatitis B virus infection (HBV) is a world health problem. Health care workers (HCWs) are at high risk to exposure and infection with HBV. This study aims to determine the seroprevalence of HBV infection among HCWs and recognize the risk factors associated with their infection in public hospitals in Taiz city, Yemen.

Across sectional study including HCWs from public hospitals in Taiz city which was conducted from 15/8/2021 to 20/9/2021.

A questionnaire was performed to collect data from participants on sociodemographic (age, gender) and risk factors (job, vaccination status, exposed to injuries). Blood samples were collected. HBV markers (HBsAg and HBc antibodies) were detected by using Enzyme linked immunosorbent assay (ELISA) test. Data of testing results and questionnaire were analyzed by SPSS. Among 179 participants the overall seroprevalence of HBsAg was 1.68% and 44.7% were detected exposure to HBV (positive for HBsAg and HBc antibodies). A high seroprevalence was found among males, young age HCWs and midwifes, and a highexposure to HBV was reported among physicians' assistances. More than two-thirds of workers (68.2%) were non-vaccinated. All seropositive HBsAg participants were non-vaccinated. Most of HCWs (81.6%) were exposed to needle stick injury (NSI) and other sharp injuries. Most of these results are from NSI (76.5%). Laboratory technicians and nurses were at the highest risk exposure for NSI and others stick injuries. Older age HCWs, laboratory technicians and Yemen Swedish Hospital were found to be at the highest risk exposure for NSI and others stick injuries.

Continuous vaccination, occupational safety and training among HCWs must be reassessed to reduce HBV infection and the associated risk factors.

Keywords: Seroprevalence; hepatitis B virus; Hepatitis B surface antigen; health care workers.

Introduction:

HBV is an enveloped DNA virus and belongs to *hepadnaviridae* that infects the liver. Depending on genetic classification, HBV can be divided into ten genotypes (A to J) (Richman *et al.*, 2020). It attacks the hepatocyte cells and that can cause acute or chronic inflammation. Advanced chronic hepatitis B infection can be leading to sever complication as hepatocellular carcinoma (HCC) (Thomas *et al.*, 2015). In the world, greater than two billion persons are exposure to HBV (Vittal & Ghany, 2019). World Health Organization (WHO) had been reported that in 2015, 257 million persons representing 3.5% of the world population, had an evidence of chronic hepatitis B virus (CHBV) infection (World Health Organization, 2017). From these, more than 600000 can die, because of CHBV (World Health Organization, 2015). In Yemen, ancient studies estimated that varies prevalence, from high prevalence to intermediate (Al-Shamahy, 2000; Sallam *et al.*, 2003). However, other studies reported lower prevalence from intermediate at 4.2% by Salam *et al.*, 2012 to low at 1.8% by Gacche *et al.*, 2012 (Gacche, 2012; Sallam *et al.*, 2012).

HBV can be transmitted vertically from mother to newborn infant during delivery as major (Vittal & Ghany, 2019). In addition, HBV is can be transmitted a sexually and through exposure to blood and body fluids (stick injuries and blood transfusion) (Sahiledengle *et al.*, 2020).

HCWs define as all paid and unpaid individuals supplying health care, working or training in a health care center. HCWs exposure to more 20 pathogens(Schillie *et al.*, 2018) . Mostly, HIV, HBV and HCV are the best cases of occupational infection (AlJohani *et al.*, 2021; Tarantola *et al.*, 2006). WHO is reported 3 million HCWs are exposed to blood borne pathogens per year. From these, approximately two millions are exposed to HBV (Sahiledengle *et al.*, 2020). Furthermore, 66, 000 can be HBV infection (Prüss-Üstün *et al.*, 2005). Moreover, WHO reported that 40% of HBV infection among HCWs is the result of occupational exposure (Arora *et al.*, 2010). New study estimated that intermediate prevalence was 2.3% of HBV infection among HCWs in the world (Mahamat *et al.*, 2021). In African region, previous studies suggested that variable ranging prevalence of HBV among HCWs from region to region between high to low risk. As an example,

10.6% in Cameroon (Akazong *et al.*, 2020), 8.1% in Uganda (Ziraba *et al.*, 2010), 2.1% Nigeria (Orji *et al.*, 2020), and 1.5 in Egypt (Reem *et al.*, 2017). In Yemen, although preceding studies estimated that variable prevalence of HBV infection among HCWs from 9.9% to 5.3%, a new study presented by 2.7% (Al Makdad *et al.*, 2020; Shidrawi *et al.*, 2004; Waheed *et al.*, 2020). In Asian region, previous studies reported that the prevalence of HBV infection from 0% in Korea (Lee *et al.*, 2017) to high risk in Bangladesh by 8% (Biswas *et al.*, 2015). Other countries appeared as 6.2 in Indonesia (Wijayadi *et al.*, 2018), and 2% in Georgia (Butsashvili *et al.*, 2012). In European Union/European Economic Area (EU/EEA), the prevalence of HBV infection was as low risk by 0.6% to 2.2% (Tavoschi *et al.*, 2019).

Anti-HBc antibody is an important test among HCWs. This is because it is related to exposure to HBV infection (Ganczak *et al.*, 2019). The prevalence of antibodies against core antigen was an investigation in some countries in different regions in the world. The highest seroprevalence was found in the Asian region in Bangladesh (48.7%) (Biswas *et al.*, 2015), followed by Georgia (29%) (Butsashvili *et al.*, 2012) and Indonesia (19.2%) (Wijayadi *et al.*, 2018). However, in Malaysia, it yielded as lowest by 5.5% (Hudu *et al.*, 2016). In the Middle East, although, the prevalence of anti- HBc antibodies is high in Morocco (28%) (Djeriri *et al.*, 2008) and low in Saudi Arabia (Alqahtani *et al.*, 2014). In European Union, previous studies showed that varying prevalence of anti- HBc anti-bodies. Such as, in Germany was yielded between 5% to 8% (Wicker *et al.*, 2008). However, in Poland estimated that 12.1% (Ganczak *et al.*, 2019). HCWs in Yemen are at risk of exposure to HBV. Previous studies counted changing seroprevalence of HBcAg antibodies among participants from 17.8% to 32% (Al Makdad *et al.*, 2020; Shidrawi *et al.*, 2004). In Yemen, previous studies were yielded HCWs high risk exposure to blood and body fluids, high risk exposure to HBV and high to low risk infected by HBV (Abkar *et al.*, 2013; Al-Abhar *et al.*, 2020; Al Eryani *et al.*, 2019; Al Makdad *et al.*, 2020; Shidrawi *et al.*, 2004; Waheed *et al.*, 2020). So that, this study was aimed to determine the seroprevalence of HBV among HCWs in Taiz city, Yemen (by detection of HBsAg and anti-HBc), the highest HCWs group at risk of HBV infection and the common risk factors mediated their infection.

Methods:

Study Design

This study was design to determine seroprevalence of HBV among HCWs and discover if the HBV infection it associated with gender, age, job, NSI and vaccination status of HCWs.

Study population

This cross-study was conducted between 15/8/2021 and 20/9/2021 among HCWs at the public hospitals in Taiz city, Yemen. Samples were collected from HCWs (physicians, physician's assistants, nurses, midwifes and laboratory technicians) and comprised 179 medical staff. Visiting practitioners and medical students were shut out from the study. The estimated sample size was derived using the following formula:

$$\text{Sample number (n)} = \frac{Z^2 \times (p) \times (1-p)}{d^2}$$

where, Z = Level of significance (1.96) for a confidence interval of 95%, p=prevalence of HBV among HCWs in Yemen and d = Margin of error of setting a significance level of 0.05 (i.e., 5%) (Waheed *et al*., 2012).

Medical ethics approval

Letters were provided by faculty of sciences under code 854, 855, 856, 857, 858, 859, 860. Final approval was obtained from head of hospital for sample collections.

Questionnaire Meeting:

Over all questionnaire meeting was offered to all participants. Data regarding sociodemographic (age, gender) and risk factors (job, vaccination status, exposed to injuries) were collected from participants.

Samples collection:

Approximately 3-5 ml venous blood was collected in gel tubes which were taken from each HCWs and allowed to clot at room temperature. Samples were then centrifuged at 1000 *xg* for 10 minutes. Then, the serum was collected to an eppendorf. These tubes stored at -40 to -80 °C in boxes at National Center of Public Health Laboratories, Taiz city (Waheed *et al*., 2020).

Detection of HBsAg by ELISA:

Serological testing was performed to detect HBsAg by using ELISA (Fortress diagnostic ltd, unit 2c antrim technology park, antrim, BT41 1QS, United Kingdom) for diagnosis of HBsAg.

Methods:

Primary, reagents and samples were allowed to arrive room temperature for 30 minutes. After that, all wells were numbered as one blank, three negative control, two positive control, and the remaining were used for testing. After good mixing of specimens by micropipette, positive control, negative control and specimens were added 50µ to the positive control, negative control and specimen's wells. The conjugate was added to all wells except blank and mixed by tapping the plate gently. Then, plates were sealed with a cover and incubated at 37^{o}c for 60 minutes. At the end of incubation, all wells were washed five times with 400µ diluted wash buffer. A soak was allowed time at least 30-60 seconds and aspirated. Next, from chromogen A and chromogen B solution were dispensed 50µ to all wells, including blank, mixed by taping the plate gently, and incubated at 37^{o}c for 15 minutes, avoiding light. After fifteen minutes, stop solution was dispensed 50µ to each well by multichannel pipette and mixed gently. Finally, the plate reader was calibrated with the blank well, and the absorbance was read at 450nm (during 5 minutes after added stop solution) (Huri *et al*., 1992).

Calculation of HBsAg Results:

Cut-off (C.O) = Nc × 2.1 (Nc= the mean absorbance value for three negative control).

Result of sample = S / C.O (S= the absorbance value of specimen and C.O= the cut-off value).

Interpretation of HBsAg Results:

If any test gave a result of less than one (S/C.O < 1, it was estimated as negative. But, it counted as positive when it gave result more than or equal to one (S/C.O > or =1).

Detection of Anti-HBc Antibodies:

Immunoserological testing was carried out to find anti-HBc antibodies by using ELISA (RPC "Diagnostic system" Ltd) to detect anti-HBc antibodies.

Methods:

Before use, all specimens and reagents were allowed to reach room temperature for 30 minutes. Next, all wells were numbered as blank, two positive control, three negative control, and the remaining were used for testing and good mixing by micropipette. Then, positive and negative control, and specimens were added 50µ to positive control, negative control and specimens wells, respectively. After that, the conjugate was added 50µ to all wells except blank by multichannel pipette and mixed by tapping the plate gently. The plate was covered with cover and incubated at 37 °C for 60 minutes. In an hour, carefully, the contents were taken out from the wells and all wells were washed by 380-400µ of working solution. A soak was allowed time at least 40 seconds and aspirated. This procedure was repeated four times by using a multichannel pipette. After that, the substrate was added 100µ to each well, mixed by taping the plate gently and incubated at 18-24 c^o for 30 minutes in the dark place. By using the multichannel pipette, the stopping reagent was added 50µ into each well, and the contents were mixed by careful tapping on the edge of the plate. At last, the absorbance was read to each well at 450nm.

Calculation of HBc Antibodies Results:

Cut-off (C.O) = (mean absorbance value of negative control × 0.5) − 0.500.

Interpretation HBc Antibodies Results:

If any test gave result ≤ cut-off, it is counted as positive. However, it is estimated as negative when gave result > cut-off.

Statical Analysis:

Data of testing results and questionnaire were analyzed by SPSS (Statistical Package for the Social Sciences) (version 24.0). Descriptive statistics was used to describe the demographic characteristic of participants associated with HBV infection and custom tables Analysis was used to identify factors associated with HBV infection. Univariable and multivariable analyses were performed using seropositivity for HBsAg and anti-HBc antibodies as dependent variables and clinical variables (age, gender, job, hospitals, vaccination status, and risk exposure to NSSI). Independent T test and one-Way Analysis of variance (ANOVA), were requirement to estimated P value that's < 0.05 was considered statistically significant.

Results:

Relationships between HCWs and HBsAg

Overall seroprevalence of HBsAg was found to be 1.68% (3/179) in study participants HCWs.

Depending on gender, there were 2.6 % of males and 1% of females were HBsAg positive. No significant difference in HBsAg was found between gender (P = 0.096) (Table 1). The highest rate seroprevalence of HBV infection was found in the age group 18-29 rate 3.4%, followed by the age group (> 50 years old) (3.3%). There was no a significant statistically difference between age groups and HBsAg seroprevalence in HCWs (P = 0.384).

Five job groups were involved in this study, which included 40 patients (22.3%) in physicians patients, 41 patients (22.9%) in nurses patients, 33 patients (18.4%) in physician assistances patients, 30 patients (16.8%) in midwifes patients and 35 patients (19.6%) in laboratory technicians, these groups. Depending on job, the seroprevalence of HBsAg rates were found to be 2.5%, 0%, 3%, 3.3% and 0% respectively. There was no significant difference between HBV infection among HCWs groups (P=0.682) (Table 1).

The blood samples were collected from different public hospitals in Taiz city. This included Republican Hospital, Al-Thawra General Hospital, Military Hospital, Al-Modfar General Hospital, Yemen Swedish Hospital, Al-Ta'awn Hospital, and Al-Noor Hospital.

The highest HBsAg seroprevalence was found in Al-Thawra Hospital (5.3%) (2/38), followed by Al-Modfar General Hospital (1/29). In contrast, no HBV infections were found in the remaining hospitals. There was no a significant difference in HBsAg seroprevalence among these hospitals (P = 0.499) (Table 1).

The majority of HCWs in this study were non-vaccinated 122 (68.2%) while 57 (31.8%) were vaccinated. Moreover, according to the dose of vaccination, most vaccinated participants administered one dose 11.2%, followed by three doses 10.6% and two doses 10.1%. All vaccinated participants in this study, showed no infection with HBV compared to non-vaccination, where 3 of them (2.5%) were infected with HBV (Table 1). There was statistically significant difference in seroprevalence of HBsAg between vaccinated and unvaccinated.

Relationships between HCWs and HBc antibodies

Overall seroprevalence of exposure to HBV (anti-HBc) was found to be 44.69% in participated sample. Anti-HBc antibodies were slightly higher in males 35(45.5%) than females 45(44.1%) (Table 2). No significant differences of HBV exposure between males and females (P = 0.730).

The highest prevalence of anti-HBc was found in old participated more than 50 years by 17 (56.7%), compared to 39% in lower age (18-29) (Table 2). It was noted that there was no statistically significance among age groups regarding anti-HBc antibodies seroprevalence (P = 0.402).

The lowest seroprevalence exposure to HBV appeared in laboratory technicians via 12(34.2%). However, the highest prevalence was shown in physician assistances as 57.6%. There were no significant differences among job groups (P = 0.353).

Among the 57 vaccinated subjects, 26(45.4%) HCWs were exposed to HBV. However, from 122 non-vaccinated subjects, 54 (44.3%) participated were positive to anti-HBc antibodies. There was no significant difference (P = 0.750).

Four groups were involved in this study, which included 137 participants (76.5%) in NSI, 7 participants (3.9%) in NSSI, 2 participants (1.1%) in others and 33 (18.4%) in not exposure.

Depending on exposure to NSI and others stick injuries, the lowest seroprevalence of HBc antibodies was found among NSI (45.3%). However, the lowest exposed to HBV was estimated among others stick injuries (0%). There was no significant difference between risk exposure groups and HBc antibodies seroprevalence in HCWs (P =0.470).

Risk exposure to NSI and other stick injuries among HCWs

In this study, most of the HCWs were exposed to NSI and other stick injuries 81.6% (146/179). Most of these exposures were to NSI (76.5%) (137/179). Participants with no risk of exposure to NSI and other stick injuries were more infected with HBV infection (3%) compared to participant with a risk exposure 1.5%. HCWs with risk to NSI only were infected by HBV (Table 1). There is no significant differences between seroprevalence of HBsAg among different level of risk factor that HCWs expose to (P = 0.908).

All participants from Yemen Swedish Hospital were exposed to blood and body fluids by the needle. However, the lowest rate of exposure was estimated in Al-Thwara General Hospital by 60.6%. The highest rate of exposure risk in participants was found among laboratory technicians (91.4%). Which was due to NSI. However, the lowest rate of exposure risk was found in physician assistances (63.6%), 56.6% of which resulted from NSI and 6.1% due to NSSI. There was a significant correlation between HCWs and hospitals types with occupational exposure (P =0.024 and 0.010). Where was, there was no correlation between vaccination status and risk exposure to NSI and other stick injuries (Table 3)

Discussion:

Seroprevalence of HBV according to HBsAg:

This study was carried out to determine the seroprevalence of HBV among HCWs in public hospitals in Taiz city. Serological testing showed that 1.68% of participants were seropositive for HBsAg among HCWs. Similar seroprevalence was found in Ibb city among general population that appeared as 1.8% (Gacche, 2012). Similar seroprevalence was reported 1.8 in Lypia (Djeirri *et al*., 2008) and 1.5% in Egypt (Reem *et al*., 2017). The seroprevalence of HBV among HCWs in these study was higher than that reported in studies performed in Saudi Arabia, India and Brazil which were found to be 0.3%, 0.4% and 0.8%, respectively (Alqahtani *et al*., 2014; Ciorlia & Zanetta, 2005; Singhal *et al*., 2011). In comparison, the seroprevalence of HBV in HCWs in this study was lower than that reported in studies performed in previous study in the capital Sana'a (9.9%) due to introduced of vaccination program against HBV in Yemen in 1999 (Shidrawi *et al*., 2004, Sallam *et al*., 2012) and in recent study on HCWs in Taiz city which was found to be 2.76% (Waheed *et al*., 2020) due to difference in study population. In addition, the seroprevalence of HBV infection in this study was lower than that reported in studies from, Bangladesh (8%), Sudan (6.85%), Iraq (4.37%), Kenya (4.5%), and Rwanda (2.9%) (Babanejad *et al*., 2019; Biswas *et al*., 2015; Kateera *et al*., 2015a; Kisangau *et al*., 2019). These variations could be due to the low vaccination coverage and insufficient training on prevention and control in Yemen (Al Makdad *et al*., 2020). In this study, only 31.8% of the participants were vaccinated against HBV which is lower than that the reported in India as 56.5% (Singhal *et al*., 2011). In This

study, HBV infection was more seroprevalence in males (2.6%) than females (1%). Similar result was found in previous study carried out in Taiz city among general people hospitals (Sallam *et al*., 2012). Moreover, others previous studies worldwide found that males more exposed to HBV infection such as in, Ethiopia, Indonesia, Rwanda, Uganda, Tanzania and Nigeria (Asemahagn, 2020; Kateera *et al*., 2015a; Orji *et al*., 2020; Shao *et al*., 2018; Wijayadi *et al*., 2018; Ziraba *et al*., 2010). This difference is due to the fact that female's produce higher innate, antibodies, and cellular immunity against viral infection and in response to vaccination (Ruggieri *et al*., 2016). However, others previous studies worldwide showed female more exposed to HBV infection such as in, Turkey, Georgia and Sierra Leone (Acikgoz *et al*., 2020; Butsashvili *et al*., 2012; Qin *et al*., 2018).. Our study showed higher seroprevalence of HBsAg in younger age between 18 to 29 years (3.4%) compare to others age groups. These resulting from, most of HCWs at lower age (18-29 years) were non vaccinated (81.4%). Previous studies worldwide showed young age more exposed to HBV infection such as in Georgia, Iran and Uganda (Bahmani *et al*., 2010; Butsashvili *et al*., 2012; Ziraba *et al*., 2010). However, previous studies in Yemen, Indonesia, Rwanda, Sierra Leone and Ethiopia HBV infection were showed more prevalence in old age (Kateera *et al*., 2015b; Qin *et al*., 2018; Waheed *et al*., 2020, Wijayadi *et al*., 2018; Yizengaw *et al*., 2018). The highest seroprevalence rates of HBsAg were 3.3% and 3% in Midwifes and physician assistances, because most HCWs in these groups were reported as the youngest (18-29 years). Previous studies worldwide in Georgia, Libya, Sierra Leone and Ethiopia found that nurses, physicians and laboratories technicians were more HBV infection seroprevalence (Butsashvili *et al*., 2012; Elzouki *et al*., 2014; Qin *et al*., 2018; Yizengaw *et al*., 2018). Depending on hospitals types, the highest seroprevalence of HBV infection was found in Al-Thawra General Hospital as 2(5.3%) followed by Al-Modfar General Hospital as 1(3.4%). These could be resulting from weak proper precaution against HBV infection (Yizengaw *et al*., 2018), lack of special training and most HCWs in these hospital were showed non vaccinated (80.9%). In this study, most HCWs were non vaccinated (68.2%) and vaccination status (vaccination and non-vaccination) gave significant contribution to the risk of current infection (P = 0.015). In this study, all HCWs were positive for HBsAg that’s showed non-vaccination. Same result reported by Wheed *et al*. (2020) in Taiz city (Waheed *et al*.,

2020). This result, suggested that vaccination was protecting HCWs from exposure to HBV infection. Compared to this study, previous studies in Saudi Arabia and Brazil showed very low seroprevalence of HBV among vaccinated HCWs at (0.3%) and 0.8% respectively. This could be due to good program vaccination and training for HCWs. Most HCWs in Saudi Arabia and Brazil had taken vaccination (84.7% and 86.4%) (Alqahtani *et al*., 2014; Ciorlia & Zanetta, 2005). Similar results were showed in previous studies in Poland (4.8%) and Libya (3.9%) *(*Elzouki *et al*., 2014*;* Ganczak *et al*., 2019).

Seroprevalence of HBV according to anti-HBc antibodies:

This is the first study about the seroprevalence of anti-HBc antibodies among HCWs in Taiz city. The seroprevalence of anti-HBc seropositivity in this study was 44.7% which in lower than seroprevalence in Uganda (48.1%), Libya (51.4%) and Bangladesh (48.7%) (Biswas *et al*., 2015; Elzouki *et al*., 2014; Ziraba *et al*., 2010). Two previous studies carried out in Sana city-Yemen showed lower ratios of anti-HBc seropositivity as 17.85 (Al Makdad *et al*., 2020) and 32% (Shidrawi *et al*., 2004). However, other studies in Saudi Arabia, Turkey, Malaysia, Germany, Lypia and Poland reported even lower anti-HBc seroprevalence at 8.7%, 1.2%, 5.5%, 5%, 8.5% and 12.1%, respectively (Acikgoz *et al*., 2020; Alqahtani *et al*., 2014; Elzouki *et al*., 2014; Ganczak *et al*., 2019; Hudu *et al*., 2016; Wicker *et al*., 2008), respectively (Acikgoz *et al*., 2020; Alqahtani *et al*., 2014; Elzouki *et al*., 2014; Ganczak *et al*., 2019; Hudu *et al*., 2016; Wicker *et al*., 2008), respectively. In our study, HCWs, especially physician assistances and midwifes were at High risk to exposure to HBV due to inconsistent use or inefficient recommended barrier prevention measures to prevent exposure to HBV (Malka *et al*., 2012). However, previous studies in Poland (Ganczak *et al*., 2019), Georgia (Butsashvili *et al*., 2012) and Bangladesh (Biswas *et al*., 2015) showed high prevalence of anti-HBc among nurse. In Yemen, previous study was recorded the highest incidence of hepatitis B virus infection among nurses (Al Makdad *et al*., 2020). Seroprevalence of anti-HBc antibodies among participants increased with age. The highest anti-HBc seroprevalence was found in medical staffs with more than 50 years of age. Similar result was found in previous study carried out in Yemen (Al Makdad *et al*., 2020). This is could be resulted from long time exposure to blood and body fluids. Moreover, the same result was reported by previous studies in Poland, Iran and Uganda

(Bahmani *et al*., 2010; Ganczak *et al*., 2019; Ziraba *et al*., 2010), respectively. This study showed nearly equal seroprevalence of anti-HBc anti-bodies among males (45.5%) and females (44.1%). Previous studies in Yemen(Al Makdad *et al*., 2020), Uganda (Ziraba *et al*., 2010) and Sierra Leone (Qin *et al*., 2018) showed females more exposure to HBV rather than males. However, in Yemen (Shidrawi *et al*., 2004), Indonesia (Wijayadi *et al*., 2018) and Turkey (Acikgoz *et al*., 2020), anti-HBc was showed higher in males than females. In the present study, the highest seroprevalence of anti-HBc anti-bodies was found in Al-Ta'awn hospital (73.3%) followed by Al-Thawra General Hospital (60.5%). The present study reported a significant difference in exposure to HBV between the hospitals (P =0.03). In addition, significant differences were noted between different public hospitals in this study. These significant variations in seroprevalence of anti-HBc HCWs between Republican Hospital with Al-Thawra General Hospital (P =0.06), Yemen Swedish Hospital (P =0.027) and AL-Ta'awon Hospital (P =0.04). This reflects that these hospitals did not display sufficient management and staff training against exposure to HBV as unequal degree. This study showed nearly equal seroprevalence of anti-HBc among participants were vaccinated and non vaccinated. Most HCWs in this study showed negative result to anti-HBc anti-bodies. This reflects viability of vaccination against HBV. However, in Indonesia, non-vaccination were professions most having positive anti-HBc screening results (Wijayadi *et al*., 2018). In Yemen, previous study, showed higher prevalence of anti-HBc among non-vaccinated rather than vaccinated (Al Makdad *et al*., 2020).

Risk Factors associated with HBV infection among HCWs

In the present study, more than 2/3 of medical staffs (81.56%) had exposed to NSI and other stick injuries. The highest risk was due to NSI (75.3%). This ratio is higher than previous studies in, Yemen (17.4 to 60%, Belgrade town (60.6%), Egypt (67.9%), Burkina Faso (29.1%) and Poland (27.8%) (Al-Abhar *et al*., 2020; Al Makdad *et al*., 2020; Auta *et al*., 2017; Ganczak *et al*., 2019; Hanafi *et al*., 2011; Marković-Denić *et al*., 2013, Shidrawi *et al*., 2004; Waheed *et al*., 2020). However, this ratio is lower than previous studies in, Morocco (89.2) and North Africa (82.9%) (Auta *et al*., 2017). A high risk of NSI exposure was reflected low training on infection prevention. Depending on age, similar of risk of exposure was found all age

groups, nearly at 83%, except in youngest HCWs (18-29 years), which was slightly lower than other groups (76.3%). These differences may be attributed to the difference in period of working experience that is shorter in youngest HCWs. Previous study in Egypt was found a high risk of exposure to NSI in young age (Hanafi *et al*., 2011). This study revealed statistically significant differences risk of exposure to NSI and other stick injuries between different types of jobs (P = 0.024). Also, there was significant difference between different types of physician's assistances and laboratory technicians (P =0.01), midwifes (P =0.021) and nurses (P =0.029). The highest risk of exposure was found in laboratory technicians (91.4%), followed by nurses (86.3%) and midwifes (83.3%). Most of these risk groups of exposure were due to exposure to NSI. This is resulting from a high daily volume of lab examinations, that require the use of needle and sharp object. In addition, most of laboratory technicians in the hospitals and nurses are responsible for recapping needles (Butsashvili *et al*., 2012; Abkar *et al*., 2013). Recent study in Yemen among nurses found that few nurses (14.7%) had good practice of NSI preventive measures (Alwabr, 2018). Most of the HBsAg positive HCWs 2/3 (66.7%) were exposed to NSI. This reflects the role of exposure to NSI in transmit of HBV. In general, the seroprevalence of HBsAg among HCWs who exposure to NSI and other stick injuries in this study was found to be 2/146(1.4%). This resulting from exposure to NSI 1.5% (2/137). These results of HBsAg are lower than the results that found in Romania (1.7%), Germany (1.7%), Indonesia (4.4%), Georgia (1.5%), Sierra Leone (7.7%) and Tanzania (6.8%) (Butsashvili *et al*., 2012; Malka *et al*., 2012; Qin *et al*., 2018; Shao *et al*., 2018; Wicker *et al*., 2008; Wijayadi *et al*., 2018). However, in this study, seroprevalence of HBsAg for HCWs that non- exposed to NSI showed higher than exposed by 3%. Unfortunately, some HCWs could not remember if they exposed to NSI and other injuries during their works. The result of this study was similar to that result found by researchers in Indonesia and Georgia that showed the seroprevalnece of HBsAg was higher in non-exposures (7.9%) compared to NSI risk exposure (2.6%) (Butsashvili *et al*., 2012; Wijayadi *et al*., 2018). But, in Sierra Leone and Tanzania, the results were lower as 4.5% and 5.1% (Qin *et al*., 2018; Shao *et al*., 2018), respectively. This is resulting from the risk of NSI in transmitting HBV to medical staff. The risk of NSI in transmitting HBV to medical staff depended on the repeated exposure to NSI and the prevalence of of infectious patients (Wicker *et al*., 2008).

In this study, the seroprevalence of anti-HBc was showed higher among HCWs were non-exposed to NSI and other stick injuries (48.5%) as compared with exposed (43.8%). Similar result was found in previous study carried out in the capital of the Republic of Yemen (Shidrawi *et al*., 2004). Moreover, a previous study conducted in Georgia showed results that were comparable (31% for non-exposed and 27% for exposed) (Butsashvili *et al*., 2012). In contrary, Wijayadi *et al*., (2018) found that among HCWs in Indonesia who had NSI and other stick injuries, the seroprevalence of anti-HBc was 24.4% compared to 15.9% for those who had not (Wijayadi *et al*., 2018). Moreover, Qin *et al*., (2018) showed a higher seroprevalence of anti-HBc among those exposed versus those not exposed, appearing at 13.6% and 13.1% respectively (Qin *et al*., 2018). However, our analysis found no correlation between exposure to NSI and stick injuries and seroprevalence of anti-HBc.

Conclusion:

This study found a low seroprevalence of HBsAg among HCWs. Midwifes and physician's assistants are more infected than other medical staff. HCWs with younger age at high risk for HBV infection. All HCWs who were infected by HBV were unvaccinated. Few rates of HCWs vaccinated against HBV infection. Exposure to HBV (anti- HBc antibodies) are high in physician's assistance and midwifes. The majority of HCWs (> two-third) are exposed to stick injuries. High ratio are of this exposed to NSI.

Recommendations:

Vaccination program vaccination against HBV infection should be continued and improved. The establishment of national policy and road map of what should be achieved to prevent occupational stick injuries by implantation of biosafety risk assessment Ministry of health has to increase the training program for all HCWs in hospitals which definitely will improve their knowledge about the risk of HBV and other nosocomial infection they face during their works in public hospitals. New studies related to the risk of HCWs exposure to HBV and others nosocomial infection have to carry out

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Table (1) Relationships between HCWs and HBsAg

			HBsAg (+)		χ^2	P value
Variables	**Frequency**	**Percent**	**N**	**%**		
Gender						
Male	**77**	**43%**	**2**	**2.6**	**0.696**	**0.096**
Female	**102**	**57%**	**1**	**1**		
Age by years						
18-29	**59**	**33**	**2**	**3.4**	**3.086**	**0.384**
30-39	**53**	**29.6**	**0**	**0**		
40-49	**37**	**20.7**	**0**	**0**		
50^+	**30**	**16.8**	**1**	**3.3**		
Job						
Physicians	**40**	**22.3**	**1**	**2.5**	**2.328**	**0.682**
Nurses	**41**	**22.9**	**0**	**0**		
Physician assistances	**33**	**18.4**	**1**	**3**		
Midwifes	**30**	**16.8**	**1**	**3.3**		
Laboratory staffs	**35**	**19.6**	**0**	**0**		
Hospitals						
Republican Hospital	**42**	**23.5**	**0**	**0**	**5.429**	**0.499**
Al-Thawra General Hospital	**38**	**21.2**	**2**	**5.3**		
Military Hospital	**30**	**16.8**	**0**	**0**		
Al-Modfar General Hospital	**29**	**16.2**	**1**	**3.4**		
Yemen Swedish Hospital	**22**	**12.3**	**0**	**0**		
Al-Ta'awn Hospital	**15**	**8.4**	**0**	**0**		
Al-Noor Hospital	**3**	**1.7**	**0**	**0**		
Vaccination status						
Vaccination	**57**	**31.8**	**0**	**0**	**1.426**	**0.015**
Non vaccination	**122**	**68.2**	**3**	**2.5**		
Risk exposure						
NSI	**137**	**76.5**	**2**	**1.5**	**0.590**	**0.908**
NSSI	**7**	**3.9**	**0**	**0**		
Others	**2**	**1.1**	**0**	**0**		
Not exposure	**33**	**18.4**	**1**	**3**		

Table (2) Relationships between HCWs and HBc antibodies

			HBc anti-bodies		χ^2	P value
Variables	**Frequency**	**Percent**	**N**	**%**		
Gender						
Male	**77**	**43**	**35**	**45.5**	**0.032**	**0.730**
Female	**102**	**57**	**45**	**41.1**		
Age						
18-29	**59**	**33**	**23**	**39**	**2.970**	**0.402**
30-39	**53**	**29.6**	**22**	**41.5**		
40-49	**37**	**20.7**	**18**	**48**		
50^+	**30**	**16.8**	**17**	**56.7**		
Job						
Physicians	**40**				**4.458**	**0.353**
Nurses	**41**					
Physician assistances	**33**					
Midwifes	**30**					
Laboratory staffs	**35**					
Hospitals						
Republican Hospital	**42**	**23.5**	**13**	**31**	**19.098**	**0.03**
Al- Thawra General Hospital	**38**	**21.2**	**23**	**60.5**		
Military Hospital	**30**	**16.8**	**10**	**33.3**		
Al- Modfar General Hospital	**29**	**16.2**	**10**	**34.5**		
Yemen Swedish Hospital	**22**	**12.3**	**13**	**59**		
Al- Ta awn Hospital	**15**	**8.4**	**11**	**73.3**		
Al- Noor Hospital	**3**	**1.7**	**0**	**0**		
Vaccination status						
Vaccination	**57**	**31.8**	**26**	**45.6**	**0.029**	**0.750**
Non vaccination	**122**	**68.2**	**54**	**44.3**		
Risk exposure						
Exposure to NSI	**137**	**76.5**	**62**	**45.3**	**2.562**	**0.470**
Exposure to NSSI	**7**	**3.9**	**2**	**28.6**		
Others	**2**	**1.1**	**0**	**0**		
Non exposure	**33**	**18.4**	**16**	**48.5**		

Table (3) Socio-demographic characteristics of study HCWs and risk exposure to NSI and other stick injuries.

Variable	Risk exposure								χ^2	P value
	NSI		NSSI		Others		Total			
	N	%	N	%	N	%	N	%		
Gender										
Male	58	75.3	4	5.2	2	2.6	64	83.1	3.42	0.331
Female	79	77.5	3	2.9	0	0	82	83.1		
Age										
18-29	43	72.9	2	3.4	0	0	45	76.3	11.9	0.214
30-39	44	83	0	0	0	0	44	83		
40-49	27	73	4	4	0	0	31	83.8		
$^{+}$50	23	76.7	1	3.3	1	3.3	25	83.3		
Job										
Physicians	30	75	1	2.5	2	5	33	82.5	24.4	0.024
Nurses	31	76.6	4	4	0	0	35	86.4		
Physician assistances	19	57.6	2	6.1	0	0	21	63.6		
Midwifes	25	83.3	0	0	0	0	25	83.3		
Laboratory staffs	32	91.4	0	0	0	0	32	91.4		
Public hospitals										
Republican Hospital	36	85.7	4	9.5	1	2.4	41	97.6	33.9	0.010
Al- Thawra General Hospital	21	55.3	2	5.3	0	0	23	60.5		
Military Hospital	22	73.3	1	3.3	1	3.3	24	80		
Al-Modfar General Hospital	23	79.3	0	0	0	0	23	79.3		
Yemen Swedish Hospital	22	100	0	0	0	0	22	100		
Al- Ta awn Hospital	11	73.3	0	0	0	0	11	73.3		
Al-Noor Hospital	2	66.7	0	0	0	0	2	66.7		
Vaccination status										
Vaccination	43	75.4	2	3.5	1	1.8	46	80.7	0.38	0.943
Non Vaccination	94	77	5	4.1	1	0.8	100	81.9		