













RESEARCH ARTICLE

SEROPREVALENCE OF THE VIRAL MARKERS OF HEPATITIS B, HEPATITIS C, AND HIV AMONG MEDICAL WASTE HANDLERS IN SOME HOSPITALS IN SANA'A CITY- YEMEN

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Abstract

Background and Objective: Hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) are highly contagious pathogens that threaten medical waste handlers who are highly exposed to these viruses due to the nature of their work. To date, little data is available on the prevalence of viral markers (HBV, HCV, and HIV) among medical waste handlers in Sana'a city, Yemen. Hence, this work was conducted to enhance knowledge of the prevalence of viral markers among medical waste handlers working in some hospitals in the capital, Sana'a.

Methods: A cross-sectional prospective study was conducted on 120 randomly selected medical waste handlers from January to June 2022. A pretested and designed questionnaire was used to collect the required data. Total 5mL of venous blood was collected. Then blood was tested for hepatitis B surface antigen and anti-HCV, as well as HIV antibody, were detected using a qualitative by rapid test cassette and positive results were confirmed by ELIZA technique.

Results: The overall positive rates for HBsAg, anti-HCV, and HIV were 9.17%, 5.0%, and 0.0%, respectively, based on the rapid test. No significant differences were detected between socio-demographic characteristics and hepatitis B and HCV infection. High rates of hepatitis B and C infection were found in the age group ≥ 41 years (9.17%) and 21-30 years (8.77%), respectively. These two viruses have also been detected among married people with a history of acute infection between 7-9 times. There was a significant correlation between HBsAg positivity and history of blood transfusion as well as between HBsAg and anti-HCV positivity and history of hepatitis B vaccination. ELISA confirmed that the rate of HBsAg was 4.17% and anti-HCV was 2.5%.

Conclusion: Appropriate training, immunization against HBV, and regular motivation of medical waste handlers on the practices of universal standard precautions are recommended to reduce transmission of hepatitis B virus, hepatitis C virus, and HIV among medical waste handlers.

Keywords: ELISA, HBsAg, HCV, HIV, Hospitals, Medical Waste Handlers, Sana'a, Yemen.

INTRODUCTION

Medical waste handlers are high exposure to infectious agents throughout the waste collection, segregation, storage, transportation, and final removal of all types of

waste that carry a high potential for infection¹. Exposure of medical waste handlers to infectious agents is the most common problem worldwide that happens as a result of poor medical waste management practices in developing countries^{2,3}. Medical waste

which is generated during hospitals activities carries a varied range of pathogens such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) which responsible for most cases of occupational infection documented in the literature^{4,5}. Transmission of these viruses is resulting from exposure to infectious blood or body fluids containing blood, blood transfusions or their products, and sexual contact. Also, in hospitals, the re-use of contaminated needles and syringes, multiple-use medication vials; infusion bags; and inadequately sterilized medical equipment are the factors contributing to the transmission of these viruses^{6,7}. The transmission of HBV is 50 to 100 times more infectious than HIV⁸.

In the year 2010, it was documented that the new cases were 33,800, 1.7 million, and 315,000, respectively, reported for HIV, HBV, and HCV resulting from the use of unsafe injections in hospitals^{9,10}. Hepatitis B and C viruses account the most frequently causes of chronic hepatitis, cirrhosis of the liver, liver failure, and hepatocellular carcinoma causing worldwide in high morbidity and mortality^{11,12,13}.

Commonly, medical waste handlers who are working in the collection, transportation, cleaning, and disposal of medical wastes are vulnerable to HBV, HCV, and HIV infection particularly in developing countries^{14,15}. According to previous reports, the medical waste handlers were infected by HBsAg (20.4%) in Ethiopia¹, HBsAg (1.3%) and HCV (0.7%) in southern Ethiopia¹⁶, HBsAg (2.3%) and HCV (2.7%) in Tripoli, Libya¹⁵, 1.59% for HBsAg in Palestine¹⁷, 6.3% for HBV and 1% for HCV in Bangladesh¹⁸, and HIV (5%) in Africa¹⁹. A study conducted previously in Yemen on 388 public health center cleaners (PHCCs) by Al-Marrani and Al-Shamahy reported that HBV and HCV were detected in 32 (8.2%), and 4 (1.03%) of them respectively. There was significant risk factors of hepatitis viruses with age group 20-24 years (OR=2.8), exposure to patients blood (OR=3), accidental stick of used needles (OR=2.3), sharp injury (OR=5.6), history of blood transfusion (OR=2.5), and hospital admission (OR=2.7). Also significant protected roles for HBV vaccine was found with infection¹⁴. In addition medical waste handlers were infected by HBsAg (20.4%) in Ethiopia¹, HBsAg (1.3%) and HCV (0.7%) in southern Ethiopia¹⁶, HBsAg (2.3%) and HCV (2.7%) in Tripoli, Libya¹⁵, 1.59% for HBsAg in Palestine¹⁷, 6.3% for HBV and 1% for HCV in Bangladesh¹⁸, and HIV (5%) in Africa¹⁹.

Yemen is one of the developing countries where the infectious pathogenic microorganisms are easily spread among the population due to the lack of an effective health system, unsafe drinking water, poor environmental sensation, and uncontrolled disease transmission²⁰⁻²⁵. The prevalence rate of positive anti-HB core antibody among the population was between 8-50% in 2000 by Al-Shamahy²⁶ and between 20% by Sallam *et al.*,²⁶. The previous studies focused on the prevalence of viral viruses among adult. Up to now, there is only limited information about the prevalence of viral markers (HBV, HCV, and HIV) among medical waste handlers is available in Yemen. So, the

current work intended to identify the magnitude of HBV, HCV, and HIV infection and their associated risk factors among medical waste handlers working in some hospitals in Sana'a city-Yemen.

MATERIALS AND METHODS

Study design and period

This is a cross-sectional prospective study in which blood specimens were collected from waste medical handlers working in three public and three private hospitals located in Sana'a city, Yemen during a period from January 2022 to June 2022.

Study population

This study was conducted among 120 medical waste handlers working in six hospitals including; Al-Gimhori, Al-Sabeen Maternal, Al-Thoawra general, University of Science and Technology, Modern European, Abdulkader Al-Mutawakel which is located at Sana'a City, Yemen.

Sample size

One hundred and twenty (120) blood specimens were randomly sampled from medical waste handlers aged between 16-60 years old working in six hospitals in Sana'a city.

Data collection

The essential data were obtained from a subject study by using a designed questionnaire. The gender, age, marital state, educational level, working area, years of service (years), and frequency of sharp injury were asked. Also, history of blood transfusion or donation, surgical operations, dental procedures, needle prick, cupping, china acupuncture, history of liver disease, their family history of liver disease, and vaccinated for HBV were gathered by interview face-face.

Inclusion and exclusion criteria

All medical waste handlers who were working at hospitals and signed informed consent were included in this study. Also, the excluded participants refused to fill the questionnaire and sign the informed consent.

Sample collection

About 5-ml of venous blood samples were collected in a plain vacutainer tube under aseptic procedures and allowed to stand for about 20 min for clotting blood before centrifuging.

Serological assay

In the rapid test, about 3 drops of the serum were transferred separately by a sterile micropipette to the wells of the test kit to detect HBsAg (LUNGENE Rapid test Cassette HBsAg, China) and HCV (LUNGE NE Rapid test Cassette Anti-HCV, China) as well as HIV antibody by rapid test Cassette (LUNGENE, China). After 15 minutes, the test results were observed. Then, the positive results for HBsAg and HCV detection were confirmed by using an enzyme-linked immunosorbent assay (ELISA) (Labsystem Reader) using a commercially available kit (Biokit, Spain) at the AULAQI Specialized Med. Lab.

Ethical consideration

The ethical approval for this study was approved by the Arwa Kingdom University Ethics and Review Committee and also permitted by the responsible subjected hospitals' administrations. The concept and

purpose of this study were explained to study participants.

Statistical analysis

The obtained data were statistically analyzed by using the SPSS program (version 20.0). A significant difference between the proportions and the variables associated with HBV infections was determined. A *p*-value (< 0.05) was considered statistically significant.

RESULTS

Socio-demographic

Most blood specimens were sampled from medical waste handlers aged between 21-30 years (47.5%), male (100%), married (61.67%), uneducated (31.67%),

working in the laboratory department (25%), and had a history of diagnosed for hepatitis test before work attending (74.17%), no one of them checked every 5-6 month (100%), every one year (19.17%), and every four years (0.83%). Also, 54.17% of study subjects had work experiences between 1-4 years and 33.33% of them said they had history of sharp injury between 1-3 times (Table 1). Table 2 shows that most of participated respondents said that they didn't have a history of blood transfusion, blood donation, surgical operation, dental procedure, cupping, china acupuncture, having liver disease, and their family had liver disease with HBV. While most of them were exposed to needle prick and vaccinated for HBV.

Table 1: Socio-demographic of participated medical waste handlers.

Variables	Examined N(%)	Variables	Examined N(%)		
Age group (in years)	≤ 20	25 (20.83)	Educational level	Illiterate	38(31.67)
	21-30	57(47.5)		Primary	19(15.83)
	31-40	29(24.17)		Junior-high	29(24.17)
	≥41	9(7.5)		Secondary	34(28.33)
Gender	Male	120(100)	Work location	Laboratory	30(25.0)
	Female	0(0)		Operating Room	18(15.0)
Marital state	Married	74(61.67)		ICU	18(15.0)
	Single	46(38.33)		Emergency	6(5.0)
History of hepatitis diagnosis:				Patients room	10(8.33)
Before work	Yes	89(74.17)		Laundry	3(2.5)
	No	31(25.83)		Outpatient	6(5.0)
Periodically	Yes	95(79.17)		Movement	29(24.17)
	No	25(20.83)		Work experience (years)	1-4
Every 5-6 month	Yes	0(0)			5-10
	No	120(100)	≥11		12(10)
Every one year	Yes	23(19.17)	Frequency of sharp injury (times)	1-3	40 (33.33)
	No	97(80.83)		4-6	38 (31.67)
Every four year	Yes	1(0.83)		7-9	6 (5)
	No	119(99.17)		≥ 10	36 (30)

Table 2: Clinically risk factors associated with prevalence of viral markers.

Variables	Yes response	No response
	No. examined (%)	No. examined (%)
Received blood transfusion	32 (26.67)	88 (73.33)
Blood donation	31(25.83)	89 (74.17)
Surgical operations	39(32.5)	81(67.5)
Dental procedures	4(3.33)	116(96.67)
Needle prick	99(82.5)	21(17.5)
Cupping	27(22.5)	93(77.5)
China acupuncture	20(16.67)	100(38.33)
History of liver disease	5(4.17)	115(95.83)
Any family member with hepatitis	14(11.67)	106(88.33)
Vaccinated for hepatitis B	61(50.83)	59(49.17)

Seroprevalence result of viral markers

The present study revealed that the seroprevalence of HBsAg and anti-HCV among medical waste handlers was 11(9.17%) and 6(5.0%), respectively. While all study subjects were free from HIV antibodies as figured in Figure 1. This result showed that the higher rate of HBs Ag and anti- HCV positivity were recorded among the age group of ≥41 years and 31-40 years, respectively, and both among married participants who

hold junior-high school education and work in ICU. Also, the study subjects who had work experience between 5 to 10 years and ≥11 years were more infected by HBsAg (16.28%) and anti-HCV (8.33%) (Table 3). In the current finding, it was noticed that the study respondents who did not periodically diagnose with hepatitis had a higher rate of HBsAg (44%) and anti-HCV (24%) while a lower rate was detected among

study respondents who had hepatitis diagnosed before work attending (Table 4).

Table 5 shows the study subjects who had a history of sharp injured between 7-9 times were found to be more exposed to both HBsAg and anti-HCV infection. Table 6 reveals that the highest seropositivity rate of HBsAg

and anti-HCV were recorded among participants who received a blood transfusion, donate blood, and were exposed to needle prick. Also, the study subjects who didn't have and their family history of liver disease with hepatitis were more infected for HBsAg and anti-HCV.

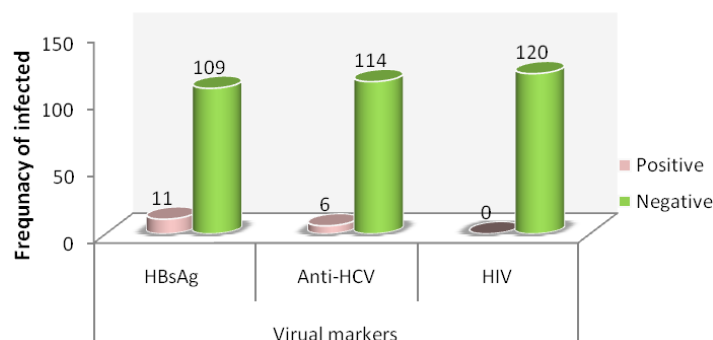


Figure 1: Seroprevalence of viral markers among medical waste handlers.

Table 3: Seroprevalence of viral markers associated with socio-demographic.

Variables		Examined No. (%)	HBsAg No. (%)	p-value	Anti-HCV No. (%)	p-value	Anti-HIV No. (%)
Age group (in years)	≤ 20	25 (20.83)	1(4.0)	0.628	0(0)	0.286	0(0)
	21-30	57(47.5)	5(8.77)		5(8.77)		
	31-40	29(24.17)	4(13.79)		1(3.44)		
	≥41	9(7.5)	1(16.67)		0(0)		
Gender	Male	120(100)	11(9.17)	0	6(5)	0	0(0)
	Female	0(0)	0(0)		0(0)		0(0)
Marital state	Married	74(61.67)	9(12.16)	0.152	4(5.41)	0.798	0(0)
	Single	46(38.33)	2(4.35)		2(4.35)		0(0)
Educational level	Illiterate	38(31.67)	4(10.53)	0.198	2(5.26)	0.057	0(0)
	Primary	19(15.83)	0(0)		0(0)		
	Junior high	29(24.17)	5(17.24)		4(13.79)		
	Secondary	34(28.33)	2(5.88)		0(0)		
Work location	Laboratory	30(25.0)	2(6.67)	0.140	1(3.33)	0.325	0(0)
	Operating Room	18(15.0)	3(16.67)		1(5.55)		
	ICU	18(15.0)	4(22.22)		3(16.67)		
	Emergency	6(5.0)	0(0)		0(0)		
	Patients room	10(8.33)	2(20.0)		1(10.0)		
	Laundry	3(2.5)	0(0)		0(0)		
	Outpatient	6(5.0)	0(0)		0(0)		
	Movement	29(24.17)	0(0)		0(0)		
Work experience (years)	1-4	65(54.17)	4(6.15)	0.456	2(3.08)	0.582	0(0)
	5-10	43(35.83)	7(16.28)		3(6.98)		
	≥11	12(10)	0(0)		1(8.33)		

*Significant statistics at p -value <0.05.

Table 4: Frequency of HBsAg, anti-HCV, and HIV antibody according to hepatitis testing.

Variables		Examined No. (%)	HBsAg No. (%)	p-value	Anti-HCV No. (%)	p-value	Anti-HIV No. (%)
Before work attending	Yes	89(74.17)	11(12.36)	0.040	6(6.74)	0.140	0(0)
	No	31(25.83)	0(0)		0(0)		0(0)
Periodically	Yes	95(79.17)	0(0)	0.075	0(0)	0.200	0(0)
	No	25(20.83)	11(44.0)		6(24.0)		0(0)
Every 5-6 month	Yes	0(0)	0(0)	N	0(0)	N	0(0)
	No	120(100)	0(0)		0(0)		0(0)
Every one year	Yes	23(19.17)	0(0)	N	0(0)	N	0(0)
	No	97(80.83)	0(0)		0(0)		0(0)
Every four year	Yes	1(0.83)	0(0)	N	0(0)	N	0(0)
	No	119(99.17)	0(0)		0(0)		0(0)

*Significant statistics at p -value <0.05; N= Not Applicable

Table 5: Frequency of HBsAg, anti-HCV, and HIV antibody according to frequency of sharp injury.

Frequency of sharp injury (times)	Examined No. (%)	HBsAg No. (%)	p-value	Anti-HCV No. (%)	p-value	Anti-HIV No. (%)
1-3	40 (33.33)	2(5.0)	0.447	2(5.0)	0.164	0(0)
4-6	38 (31.67)	6(15.79)		0(0)		
7-9	6 (5)	1(16.67)		1(16.67)		
≥ 10	36 (30)	2(5.55)		1(2.78)		
Total	120 (100)	11 (9.17)		6 (5.0)		0(0)

*Significant statistics at p -value <0.05.**Table 6: Frequency of HBsAg and anti-HCV associated with clinical risk factors of medical waste handlers.**

Variables	No. (%)	HBsAg No. (%)	p-value	No. (%)	Anti-HCV No. (%)	p-value
Received blood transfusion	Yes	32 (26.67)	0.000	32 (26.67)	2(6.25)	0.188
	No	88 (73.33)		88 (73.33)	4(4.54)	
Blood donation	Yes	31(25.83)	0.407	31(25.83)	3(9.68)	0.168
	No	89(74.17)		89(74.17)	3(3.37)	
Surgical operations	Yes	39(32.5)	0.291	39(32.5)	2(5.13)	0.965
	No	81(67.5)		81(67.5)	4(4.94)	
Dental procedures	Yes	4(3.33)	0.522	4(3.33)	0(0)	0.644
	No	116(96.67)		116(96.67)	6(5.17)	
Needle prick	Yes	99(82.5)	0.111	99(82.5)	6(6.06)	0.251
	No	21(17.5)		21(17.5)	0(0)	
Cupping	Yes	27(22.5)	0.252	27(22.5)	1(3.70)	0.728
	No	93(77.5)		93(77.5)	5(5.37)	
China acupuncture	Yes	20(16.67)	0.483	20(16.67)	1(5.0)	1.00
	No	100(83.33)		100(83.33)	5(5.0)	
History of liver disease	Yes	5(4.17)	0.472	5(4.17)	0(0)	0.604
	No	115(95.83)		115(95.83)	6(5.22)	
Any family member with hepatitis	Yes	14(11.67)	0.782	14(11.67)	0(0)	0.365
	No	106(88.33)		106(88.33)	6(5.66)	
Vaccinated for hepatitis B	Yes	61(50.83)	0.000	61(50.83)	0(0)	0.010
	No	59(49.17)		59(49.17)	6(10.17)	

*Significant statistics at p -value <0.05.

The respondent vaccinated with hepatitis was free from both HBV and HCV infection. Table 7 shows the comparison between the Cassatt and ELISA techniques. It was observed that the Cassatt technique

detected the HBsAg at 9.17% and anti-HCV at 5%. While the ELISA technique revealed that the HBsAg and anti-HCV were detected at 4.17% and 2.5%, respectively.

Table 7: Frequency of HBsAg and anti-HCV infection.

Viral markers	Cassatt technique		ELISA technique	
	No. of positive (%)	No. of negative (%)	No. of positive (%)	No. of negative (%)
HBsAg	11 (9.17)	109 (90.83)	5 (4.17)	115 (95.83)
Anti-HCV	6(5.0)	114 (95.0)	3 (2.50)	117 (97.50)

DISCUSSION

The prevalence of hepatitis viruses that consider a serious problem for Yemen health system were documented in several studies^{28,29,30}. In the current result, it was found that the seroprevalence of HBsAg was 9.17% and anti-HCV was 5% recorded among medical waste handlers. While all study subjects were free from HIV antibodies. Similar study by by Al-Marrani and Al-Shamahy¹⁴ found that HBV and HCV were detected in 8.2% and 1.03% of them respectively. Also, Mengiste *et al.*,¹ documented that the HBsAg was 20.4% reported in eastern Ethiopia. Also, the HBsAg and anti-HCV, respectively, were detected at 1.3% and 0.7% in southern Ethiopia¹⁶. However, in several reports, the seroprevalence has been reported at 2.3% for HBsAg and 2.7% for anti-HCV in Tripoli, Libya¹⁵, 1.59% for HBsAg in Palestine¹⁷, 6.3% for HBsAg in

Addis Ababa, central Ethiopia³¹, and 6.3% for HBV and 1% for HCV in Bangladesh¹⁸.

The current result revealed that the high rate of HBsAg and anti-HCV were found among the age group of ≥41 and 21-30 years, respectively. These finding are consistent with some investigation conducted in different countries^{16,18,31}. The high rate of hepatitis viruses observed in this work among older than 30 years of age may be increased with increasing exposure times to hepatitis virus infection as well as might be they are more susceptible. The high prevalence of infectious diseases in later years in Yemen resulted from the war since 2015 and so on. Also, these conflicts have been contributing significantly in increase poverty among the population, increasing costs the live requirements, and most families immigrating to other areas that are safe for them to live³²⁻⁴⁰. The present finding revealed that the married participants had the highest rate of HBsAg and anti-

HCV when compared to single participants. This result is in agreement with a study conducted in Northwest Ethiopia⁴¹, Bangladesh¹⁸, and southern Ethiopia¹⁶. The majority of enrollment in the present study who were educated in junior high-primary was more positive for HBsAg and anti-HCV. Comparable reports were obtained in Ethiopia⁴¹, Libya¹⁵, and Bangladesh¹⁸. Moreover, medical waste handlers working in hospital ICU had the highest rate of HBsAg and anti-HCV compared to others working in hospital areas and this is a similar finding by Amsalu *et al.*,¹⁶.

The highest rate of hepatitis B surface antigen in current study was detected among study subjects who had work experience between 5 to 10 years and anti-HCV was equal or more than 11 years. This finding is supported by some studies that documented that the prevalence of HBsAg was higher among study subjects who have working experience between 5-10 years^{16, 18, 31}. The current result showed that 44% of HBsAg and 24% of anti-HCV were detected among study subjects who said that they did not periodically diagnose with hepatitis and there are no previous studies to compare with this study. The high rate of HBsAg and anti-HCV was noticed among study participants who had a history of receiving a blood transfusion and blood donation. This result is similar with finding in Ethiopia¹, Spain⁴², and Japan⁴³. Therefore, the infected individuals in this study are remaining high risk and threaten the community if they donate their blood to other people. For that reason, it is preferable to exclude individuals who had previously worked in medical waste collection in hospitals by donating blood to other people.

This study showed that there was no significant association between HBsAg and anti-HCV positivity and history of frequency of sharp injury. This result is consistent with a study by Amsalu *et al.*,¹⁶. The causes of frequency of sharp injury resulting to improperly discarded needle and sharps, overfilled sharps containers, and improper handling of sharps during transportation¹⁶. These incidents may be prevented by use the PPE such as puncture-resistant gloves, penetration-proof masks, poly cotton trousers, and protective glasses. In addition, the following the precaution guideline on the correct use of waste containers and appropriate segregation of wastes at source will be minimized potential risk for medical waste handlers. This result showed that there was no significant association between HBsAg and anti-HCV positivity and history of blood donation, surgical operations, dental procedures, chronic disease, china acupuncture, cupping, and their family had a history of HBV. Positive results for HBsAg (11.11%) and anti-HCV (6.06%) in the present work were found among the participants who were exposed to needle prick while there was no one of the participants who didn't expose to needle prick was infected. The present finding was consistent with the studies that documented that needle-stick injuries among medical waste handlers and healthcare workers were the most frequent forms of exposure to HBV infections^{18, 44}. This finding indicates that the participants might be the

acquisition of the hepatitis B and C virus infection through working in hospitals.

Furthermore, the study subjects, in this work, who didn't have and their family history of liver disease with hepatitis were found to be more infected by HBsAg and anti-HCV. This result was supported by a report performed by Amsalu *et al.*,¹⁶. It was found in this study that 11(18.64%) and 6(10.17%) of non-vaccinated participated medical waste handlers were positive for HBsAg and anti-HCV, respectively with statistically significant differences ($p < 0.05$). This finding is in agreement with similar studies^{1, 31, 45}. The decrease in the prevalence of HBsAg among vaccinated individuals in Yemen has well been noticed in previous studies^{46, 47}. HBV vaccine is considered the sole protective method which is required to immunize all medical waste handlers as well as healthcare workers against HBV infection. Hence receiving immunization not only decrease medical waste handlers' chance of being infected and prevent thoughtful disease but also contributes to community protection and reduces the likelihood of virus transmission⁴⁷. By making a comparison between the cassette and ELISA techniques, the present result showed that the ELISA technique has more sensitivity and specificity for HBsAg detection. This finding has been supported in some reports^{47, 48}.

Yemen is one of the countries that use non-advance technique such as rapid test cassettes, for hepatitis virus screening among blood donors. This technique presenting more false-positive results is better for the diagnosis than those providing more false-negative results⁴⁹. A false-positive can be confirmed by using the advanced methods which are more accurate and reliable to detect the infection presence unlike the false negative results which may threaten human safety⁵⁰.

Limitations

The limitation of this study is representing on the small samples size. Also, use of rapid tests in the advanced techniques is another limitation of the study. Also, lack of advanced techniques to screen the IgG and IgM antibodies to determine is another limitation of the study.

CONCLUSIONS

In this study, it can be concluded that a significant rate of hepatitis B and C viruses observed among medical waste handlers represents a serious health problem for their life and family. The inadequate of knowledge, training, practices, and unvaccinated against hepatitis B are some factors that contributed to the prevalence of hepatitis B and C viruses among subjects studied. Therefore, health promotion, adequate immunization against hepatitis B, training on universal precaution guideline, and effective medical waste management are crucial in the prevention of HBV and HCV infection. Also, the ELISA technique is preferable for confirming the hepatitis B and C diagnosis.

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AUTHOR'S CONTRIBUTION

Edrees WH: writing original draft, literature survey. **Al-Ofairi BA:** investigation, data interpretation. **Alrahabi LM:** methodology, conceptualization. **Al-Munkari IM:** formal analysis, review. **Alawi AS:** critical review, supervision. **Al-Mashdali AHT:** data curation, investigation. **Samin GB:** data curation, investigation. **Naseer YA:** editing, methodology. **Bamoussa ZA:** data curation, investigation. **Al-Shehari WA:** critical review. All authors revised the article and approved the final version.

DATA AVAILABILITY

The data supporting the findings of this study are not currently available in a public repository but can be made available upon request to the corresponding author.

CONFLICT OF INTEREST

None to declare.

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