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Prevalence of Hepatitis C Viral Infection among Diabetes Mellitus Patients in Qassim Region, Saudi Arabia

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Abstract

The worldwide prevalence of Diabetes Mellitus (DM) associated with Hepatitis C Virus (HCV) infection are reported with higher rates of morbidity and mortality. The frequency of HCV is approximately 3-4 million cases each year and in parallel the incidence of DM is increasing alarmingly. World Health Organization (WHO) has specified that DM will be the 7th leading cause of mortality by 2030. The increasing association between HCV and DM has been indicated by some significant reports recently. HCV infection leads to hepatic steatosis and rapid insulin resistance, which in turn upsurges the risk factors for hepatic fibrosis and hepatocellular carcinoma. This study is designed to examine the association between HCV and DM, and different risk factors associated with HCV infection in Qassim region, Kingdom of Saudi Arabia (KSA). A total of 634 blood samples were obtained from diabetic and non-diabetic patients. These blood samples were first screened for HCV infection by enzyme-linked immunosorbent assay (ELISA) and positive samples were again confirmed by TaqMan HCV quantitative test and the viral load in different samples was estimated. The HCV prevalence was identified as 2.5% in diabetic patients with a positive association between HCV and DM (*RR*= 1.24, *OR*= 1.77) which is not significant statistically. However, the HCV prevalence among diabetic females was significantly different from males ($p<0.05$). The behavioural factors had no significant impact to acquire HCV infection. This study indicated a positive association between HCV and DM. Gender was an association factor in the HCV and DM status. Further studies with larger sample size is significant to properly assess the temporal relationship between HCV and DM.

Keywords: Hepatitis C Virus, Viral Load, Diabetes Mellitus Type I, Diabetes Mellitus Type II, Qassim Region

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INTRODUCTION

Hepatitis C virus infection (HCV) and Diabetes Mellitus (DM) are well-known causes of morbidity and mortality throughout the world. It is now reported that more than 170 M individuals are infected with HCV globally.[1-7] Approximately 3-4 million cases occur every year with a significant risk of progression to chronic liver disease, cirrhosis and hepatocellular carcinoma.[8,9] The Ministry of Health (MOH) in Saudi Arabia, reported 9000 new cases of viral hepatitis in 2007, in that 32% were HCV infections.[9] A Saudi study performed on blood donors showed 0.4 - 1.1% prevalence of HCV infection.[10-13] Data on prevalence of HCV infection in the general population in KSA is lacking as no population-based studies have been carried out.[9] Diabetes affects all ages, communities and continents. According to a national epidemiological health survey conducted on 16,917 Saudi subjects, the prevalence of DM was found to be 23.7%.[14-16]

HCV infection notoriously called as a silent disease caused by the HCV is a positive sense, *ss*RNA virus belonging to family *Flaviviridae* and genus *Hepacivirus.*[17] It consists of 7 genotypes and 86 subtypes. 5-25% of the patients with chronic HCV pose the risk of developing cirrhosis after 25-30 yrs.[18] Genotypes 1 and 4 are responsible for 86% of chronic HCV infections in Saudi Arabia.[19-21] HCV is primarily transmitted through exposure of infected blood.[22] Unsafely performed injection practices is the most predominant mode for transmission and it accounts to 40% of HCV infections reported worldwide.[23]

There is mounting evidence on the relationship between HCV and type 2 DM. People infected with HCV were observed to have increased risk of type 2 DM in controlled studies. HCV infection can lead to fibrosis and cirrhosis of the liver which may in turn lead to glucose intolerance and DM.[23-25] According to the histological examination on the pancreases from patients with HCV, defects in function and morphology of beta islet cells of pancreas containing desensitized response of insulin to glucose were showed.[25,26] HCV is found to induce hepatic steatosis, insulin resistance (IR) and impaired insulin signalling.[27] Tumor necrosis factor alpha (TNF-α) can affect the signalling of insulin in patients with HCV.[28,29] A large Taiwanian cohort study revealed that patients who developed DM and have chronic HCV, had the highest risk by 2-3-fold for getting liver decompensation and cirrhosis.[30] DM also raises the risk of getting hepatocellular carcinoma (HCC) in patients with chronic HCV.[31,32] The decreased rates of early virological response as well as sustained virological response (SVR) among patients with chronic HCV infection treated with a combination of ribavirin and pegylated interferon-α (PEG-IFN-α) are related to increasing levels of IR.[33-35] There is a direct relationship between IR and high viral load of HCV.[36] A study revealed that the prevalence of HCV infection was higher in type 2 diabetic patients as compared to type 1 diabetic patients (84% vs.

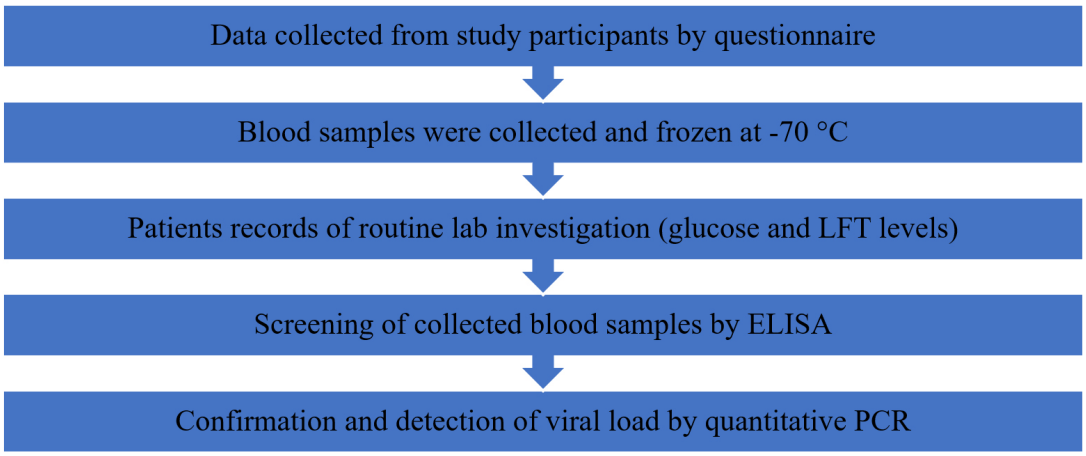

Figure 1. Flow Chart Representing the Methodology of the Study

16%).[37] Furthermore, another study indicated that type-2 diabetes was more common in patients with HCV than in patients with an HBV infection.[38] Due to insufficient data on prevalence of HCV and its association with DM in Qassim region, this study was designed to investigate the prevalence of HCV infection; its association with DM and the risk factors associated with HCV/DM comorbidities. The methodology used in the study was represented by Figure 1.

MATERIALS AND METHODS

Sample study

The cross-sectional study was conducted during the period 2018-2019 in Buraidah, Qassim. All the Saudi nationals who attended the King Fahad Specialist Hospital (KFSH), including Diabetes Centre were invited to participate in this study. Among those, 634 subjects consented to participate and were enrolled in the study by convenience sampling method (the power of the sample size estimate was 0.99). The study was conducted after obtaining due ethical clearance from the Institutional Ethical Committee and Regional Research Ethics Committee (Registration N0. H-04-Q-001). Informed consent was taken from the participants, and consent for the minors was taken from their parent/guardians. Blood samples with aseptic precautions were drawn from all study subjects who attended KFSH above the age of 10 years and were willing to participate in the study. Subjects less than 10 years of age or with pancreatic disease other than DM or with a history of it or with hepatocellular carcinoma or cirrhosis from another cause and subjects who refused to participate in the study were excluded.

Data collection

The participants signed the informed consent and the parental or guardian consent was obtained for minors, respectively. Information was also collected using a pre-structured questionnaire, which included information on demographic characteristics such as gender, age, education level and marital status. Additionally, information on the type of DM, duration of the disease, family history of DM, DM treatment information, and history of exposures to risk factors for example: sharing personal items, injections, history of hospitalization, surgical procedures etc were collected. Clinical information was gathered from routine laboratory tests and medical records: e.g., glucose level and liver function test values were recorded. According to the American Diabetes Association criteria for type 2 diabetes, a person is considered diabetic if HbA1c ≥ 6.5%, Fasting plasma glucose ≥ 126 mg/dl (7.0mmol/l), 2hr plasma glucose ≥ 200 mg/dl (11.1 mmol/l), and Random plasma glucose ≥ 200 mg/dL (11.1 mmol/L).[39]

Screening for HCV

Screening for HCV was done using Monolisa anti-HCV ELISA kit which is an indirect qualitative enzyme immunoassay for the detection of HCV infection based on the detection of anti-HCV (IgG) antibodies in serum. Positive samples were further confirmed by using TaqMan HCV quantitative test which was done in Nucleic Acid Testing (NAT) section of KFSH, Buraidah. The NAT is considered as the gold standard for detection of HCV replication.[40]

COBAS AmpliPrep/COBAS TaqMan HCV Test

The quantitative RT-PCR for the confirmation and detection of the viral load of HCV was performed using COBAS AmpliPrep/ COBAS TaqMan HCV Test. Classification of viral load result: <60,0000IU/ML was considered low, (60,

Table 1. Demographic Distribution Data in Study Participants

Demographic Data		Frequency N=634	Percent
Age	10-20 years	15	3.0%
	21-30 years	116	18.3%
	31-40 years	115	18.1%
	41-50 years	136	21.5%
	51-60 years	170	26.8%
	>60 years	78	12.3%
Gender	Male	288	45.4%
	Female	346	54.6%
Marital status	Single	105	16.6%
	Married	529	83.4%
Education level	Non-educated	135	21.3%
	School-education	251	39.6%
	University-education	248	39.1%

0000-80,0000IU/ML) was considered intermediate and >80, 0000 IU/ML was considered as high viral load.[41]

Statistical Analysis

All the data obtained was analyzed by using Excel, Epi Info™ and SPSS and descriptive statistical analysis was performed.[42,43] Results obtained on categorical measurements were designated in numbers (%). Fishers Exact and Cochran's Mantel-Haenszel tests were used to test associations between the prevalence of HCV among diabetics/non-diabetics and socio-demographic characteristics, behavioural factors and biochemical parameters of liver function by calculating the p value. The results were then presented in tables, charts and graphs. The level $p<0.05$ was set as statistically significant.

RESULTS

Demographic Characteristics

This study included 634 participants. The majority (26.8%) of participants for this study were between 51-60 years old and at least 3% were between 10-20 years of age. There ratio of females (54.6%) was more than males and more married (83.4%) than single participants in the study sample. Majority of the participants (39.6%) had either school or university level education and 21.3% reported not having any formal education (Table 1).

Diabetes Mellitus Profile for Study Participants

Among these participants, 56.1% were diabetic and 43.9% were non diabetic; 80.9% had type 2 DM and 19.1% had type 1 DM. The proportion of participants with DM <5 years, 5-10 years, 11-20 years and >20 years were 35.1%, 27.5%, 28.1% and 9.3% respectively (Table 2).

Behavioural Factors for HCV

Only 13.4% of participants had blood transfusion, 1.6% had haemodialysis, 2.1% had experience tattooing in their life, 53.9% had surgeries with differences in the number of surgeries, 70.3% had hospitalization with different times of admission. Hijama was practiced by 36.3% of participants with different times. Furthermore, 2.1% were intravenous drug users, 9.1% were sharing their personal items with others (Table 3).

Serological Test and Quantitative PCR

Out of 634 participants, only 13 were positive for anti-HCV. The prevalence of anti-HCV was found to be 2.1% (Table 4).

Table 2. History of the Diabetes Mellitus Reported by Study Participants

Chronic Illness		Frequency (N=634)	Percent
Diabetes Mellitus	Yes	356	56.1%
	No	278	43.9%
Type of Diabetes Mellitus	Diabetes Mellitus type1	68	19.1%
	Diabetes Mellitus type2	288	80.9%
Diabetes Mellitusyes	349	98.0%	
Medication	No	7	2.0%
Type of Medication	Oral	222	63.4%
	Insulin injection	83	23.7%
	Combination of both	43	12.3%
	Other	2	0.6%
Family History of Diabetes Mellitus	Yes	255	72.2%
	No	98	27.8%
Duration of Diabetes Mellitus	< 5 years	125	35.1%
	5-10 years	98	27.5%
	11-20 years	100	28.1%
	>20 years	33	9.3%

The viral load estimation showed 8 samples (61.5%) as target that not detected and the remaining were target detected (Figure 2).

Association between Demographic Characteristics and HCV

There was non-significant association (p >0.05) between all demographic data (age, gender, marital status, Education level) and HCV infection. The age groups 41-50 years, 51-60 years and >60 years showed high percentages of presence of anti-HCV, being 2.2%, 3.0%, and 3.9% respectively, compared to the other age group and male was higher with positive anti-HCV (2.4%) than female (1.7%). Married participants were also higher with anti-HCV positive (2.3%) than non-married (0.9%). The participants who were non-educated had higher percent of anti-HCV positive status (3.0%) than participants with other education levels (Table 5).

Prevalence of HCV in Diabetic and Non-Diabetic Participants

The prevalence of anti-HCV in diabetic participants was 2.5% and there was an association between HCV and diabetes mellitus as the risk difference was 13.4%, while the relative risk was 1.24 and the odds ratio was 1.77. However, the association was not statistically significant as p =0.40; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted (Table 6).

The prevalence of anti-HCV in non-diabetic participants was 1.4% and there was non-significant association between all exposures in general health (types and duration of DM, use and type of DM medication) and HCV with p >0.05 as stated in Table 7.

Association between Behavioural Factors and HCV

There was non-significant association between all behavioural factors associated with HCV in the participants including blood transfusion, haemodialysis, tattooing, surgery and times of surgeries, hospitalization and times of hospitalization, practicing hijama or times of practicing hijama, IV drug users and sharing personal items, and HCV infection. Among the participants who had blood transfusion, 4.7%, 1.8% who had history of surgeries, 2.5% of participants who had history of hospitalization and 3.0% with history of practicing hijama were anti-HCV positive (Table 8A and 8B).

HCV and Diabetes Mellitus

Figure 3 compares the prevalence of HCV and diabetes mellitus in different age groups. It shows that both age groups (51–60 years and > 60 years) have the highest prevalence of HCV and

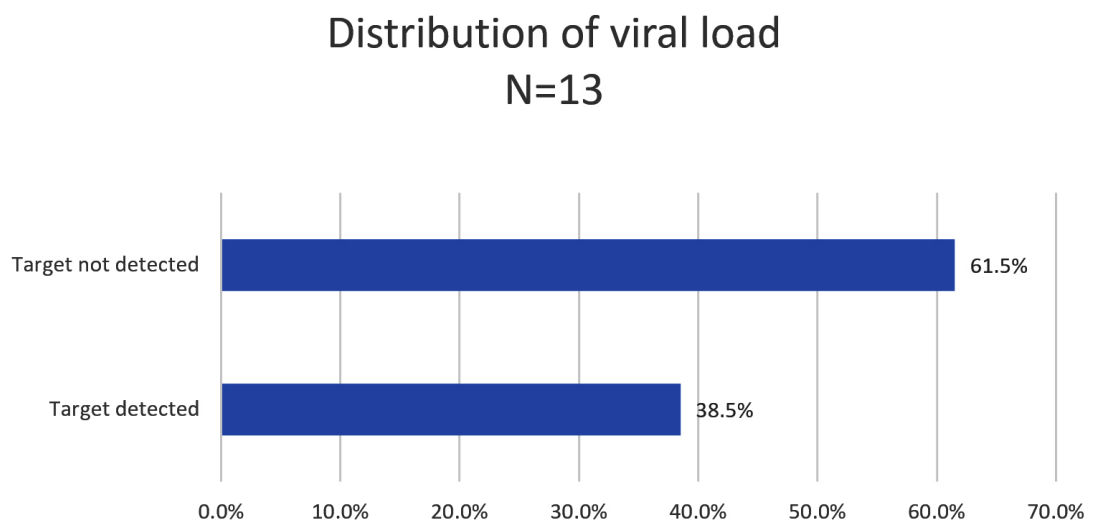

Figure 2. Reported results of viral load for positive anti-HCV including target detected and target not detected.

diabetes mellitus (0.5%), while the age groups (10–20 years and 21–30 years) have the lowest prevalence (0.0%). There was non-significant association between HCV and diabetes mellitus that considered all age groups as p =0.74, while in all age groups 10-20 years, 21-30 years, 41-50 years and >60 years, p =1.00. The age group of 31-40 years had p=0.20, and p=0.31 was in 51-60 years' age group.

There was a significant association between HCV and diabetes mellitus in female (p=0.03), with higher percentage (0.9%), while there was non-significant association between HCV and diabetes mellitus in male (p=0.46) and the percentage in male was lower (0.5%). The association between HCV and diabetes mellitus considered both gender as statistically non-significant (p = 0.50) the percentages for both gender is shown in Figure 4**.**

A percentage of 1.4% of HCV and diabetes mellitus was found in married participants, while there was no HCV and diabetes mellitus in single participants. Furthermore, there was non-significant association between HCV and diabetes mellitus that considering marital status (p=1.00 for singles, and p=0.37 for married). Non-significant association between HCV and diabetes mellitus including both single and married was found with p =0.60 (Figure 5)

Figure 6 illustrated that the highest percentage of HCV and diabetes mellitus were in university education level (0.6%), followed by non-educated level (0.5%), while the lowest percentage was found in school-educated level (0.3%). Furthermore, there was non-significant association between HCV and diabetes mellitus considering all education levels (p= 0.58), while p=1.00 was determined for both non-educated and school-educated participants, and p=0.16 was calculated for university education level.

Table 3. Reported Behavioural Factors Associated with HCV

Behavioural Factors		Frequency (N=634)	Percent
Blood transfusion	Yes	85	13.4%
	No	549	86.6%
Haemodialysis	Yes	10	1.6%
	No	623	98.4%
Tattooing	Yes	13	2.1%
	No	621	97.9%
Surgery	Yes	342	53.9%
	No	292	46.1%
Times of surgery	Once	195	57.0%
	Twice	80	23.4%
	Three times	32	9.4%
	>Three times	35	10.2%
Hospitalization	Yes	446	70.3%
	No	188	29.7%
Times of hospitalization	Once	214	48.0%
	Twice	95	21.3%
	Three times	59	13.2%
	>Three times	78	17.5%
Hijama	Yes	230	36.3%
	No	404	63.7%
Times of Hijama	Once	116	50.4%
	Twice	50	21.8%
	Three times	29	12.6%
	>Three times	35	15.2%
IV Drugs	Yes	13	2.1%
	No	621	97.9%
Sharing personal items	Yes	58	9.1%
	No	576	90.9%

Clinical Lab Findings

The available records of the levels of liver function tests among the participants with elevated alanine aminotransferase (ALT) and aspartate aminotransferase (AST) 6.7% and 9.1% were found to be anti-HCV positive, respectively. Moreover, there was non-significant association between ALT and HCV (p=0.28) and between AST and HCV (p=0.09) (Tables 9 & 10).

Association between Liver Function Tests, HbA1c and HCV

Two participants were found with high viral load as 808882 IU/ml and 1987207 IU/ml, respectively had Diabetes mellitus and one participant with the highest viral load showed a high liver function and high value of HbA1c.

Table 4. Reported Results of Anti-HCV for Study Participants

HCV ELISA	Frequency (N=634)	Percent
Positive Anti-HCV	13	2.1%
Negative Anti-HCV	621	97.9%

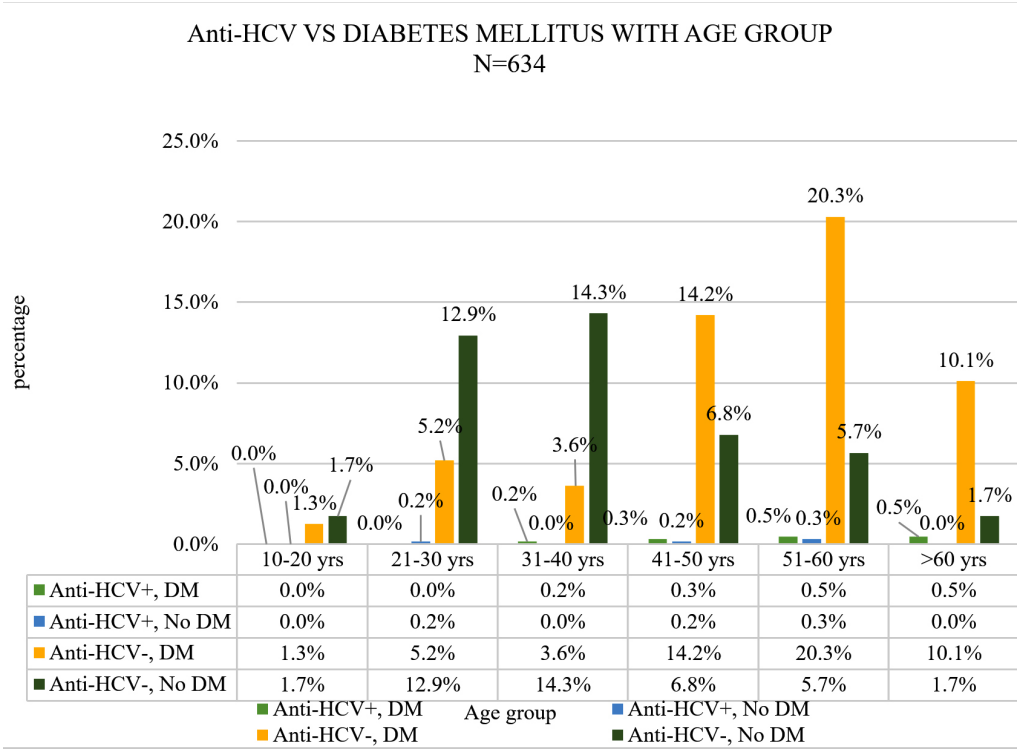

Figure 3. HCV vs Diabetes Mellitus Considered age group. Including age groups 10-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years and more than 60 years study participants.

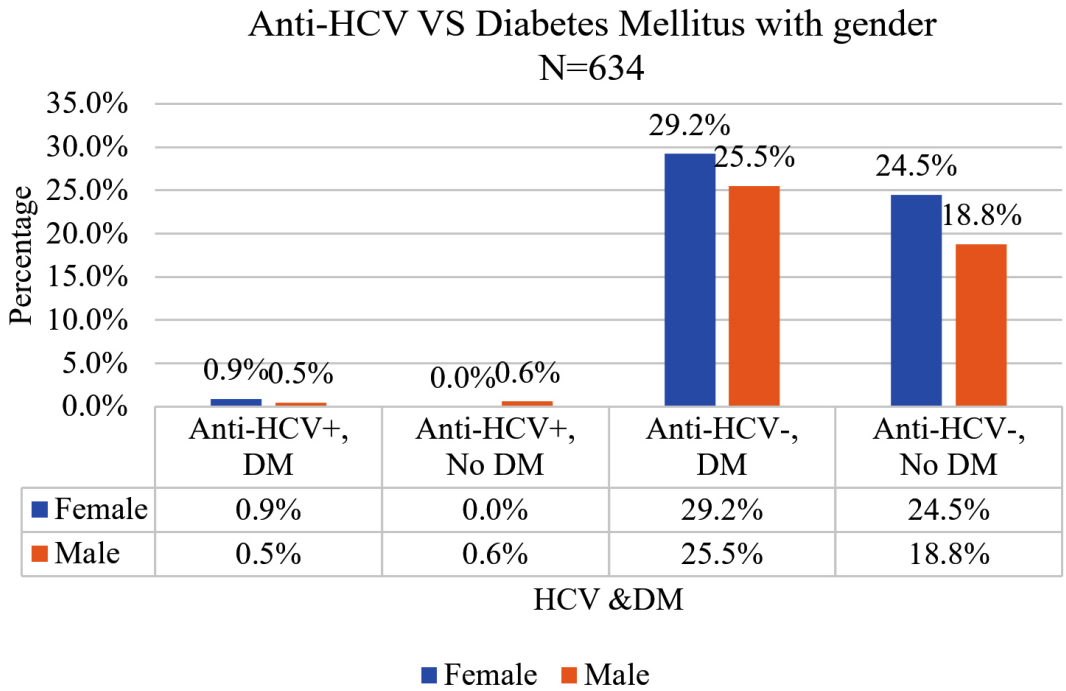

Figure 4. HCV vs Diabetes Mellitus with Gender. It includes four categories: males and females have HCV and DM, have HCV but no DM, have DM but no HCV, no HCV and no DM

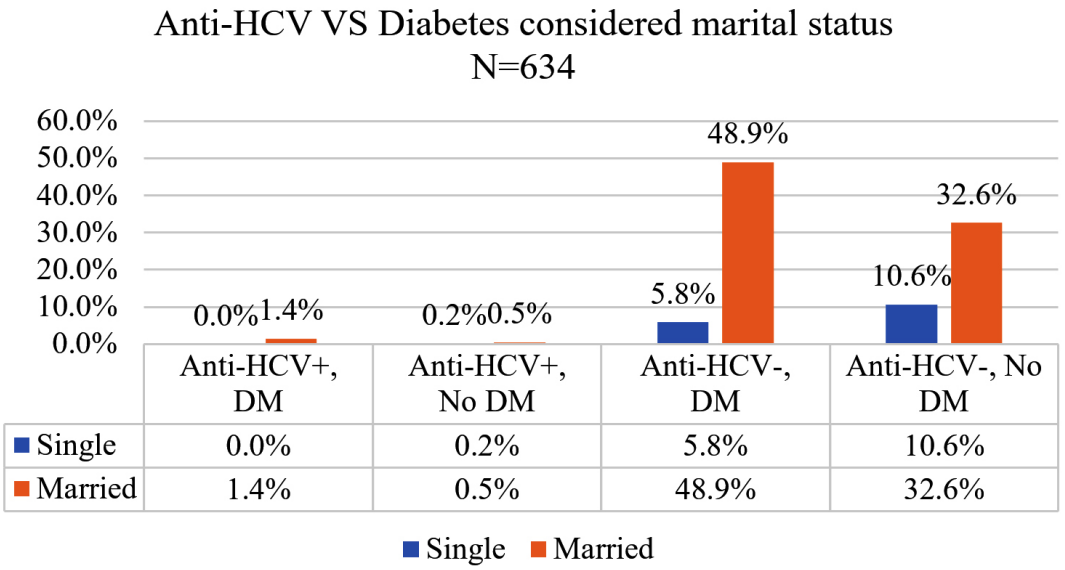

Figure 5. HCV vs Diabetes Mellitus with Marital status. Including single and married with HCV and DM, with HCV only, with DM only and without HCV and DM

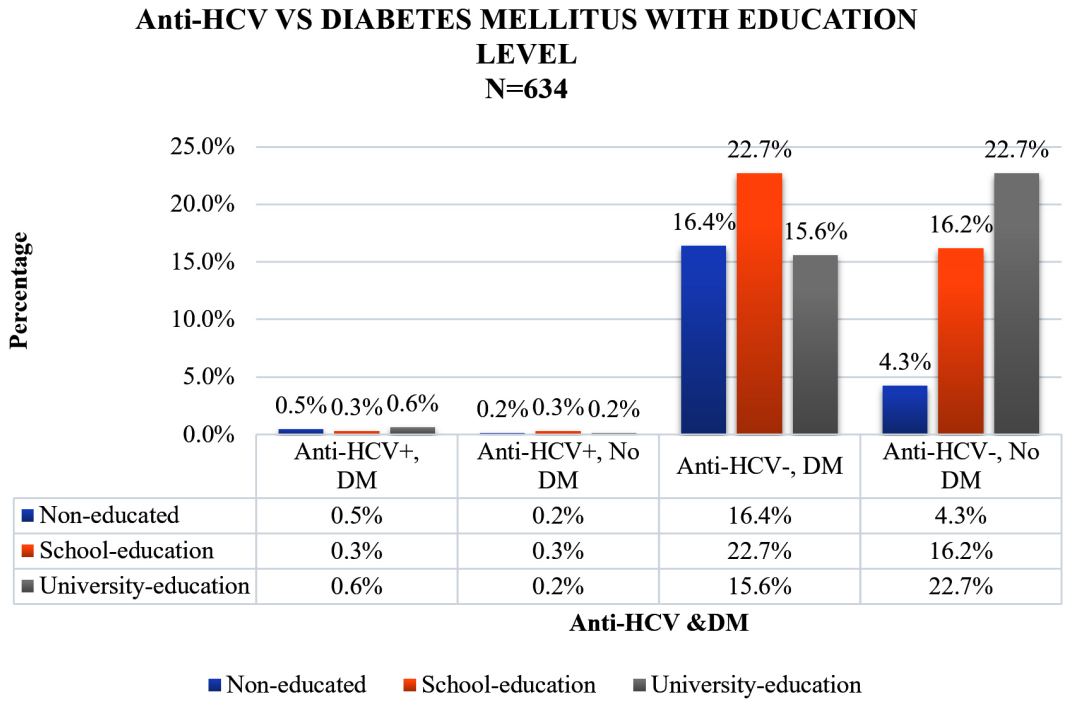

Figure 6. HCV vs Diabetes Mellitus with respect to Education Level. Including three categories: non educated, school educated and university education

Participants with low viral load showed normal liver functions (Table 11).

Among 13 positive anti-HCV, the target was not detected in 8 participants, 5 of these 8 participants were diabetic, while the other 3 were non-diabetic. Among 5 participants with sustained virological load, 4 participants had DM as shown in Figure 7.

DISCUSSION

Many studies have suggested the association between the HCV infection and DM.[44-48] There are many risk and behavioural factors which can contribute to acquiring HCV infection. The present study assessed the prevalence of HCV in diabetic and non-diabetic subjects and evaluated the association between demographic characteristics and the presence of HCV infection, viral load and DM.

In the present study, the prevalence of HCV in diabetic participants was 2.5% which was higher than what previously reported in Dammam city (1.9%),[1] in Turkey (2.2%) and in Tunisia (1.3%).[49,50] However, it was lower than what reported in USA (4.2%), in T2D reported from India (5.7%)[51,52]; in Pakistan (36%),[53] in Nigeria (11%) and among T2DM in study reported in Taiwan (6.8%).[54,55]

The prevalence of HCV in non-diabetic participants was 1.4% which was higher than what previously reported in Dammam city (0.074%)[1], in Yemen (1.3%), in Tunisia (0.6%) and in Turkey (0.5%).[49,50,56] However, it was lower than what reported in USA (1.6%) and in Taiwan (2.6%).[51,55]

A significant association between the female gender, Anti-HCV and DM was determined, which is in an agreement with the study conducted in USA, which showed that the diabetic HCV cohort had a higher proportion of female participant.[5] However, another study showed that among the HCV infected patients, males had an increase frequency of DM.[44]

This study has also showed a higher percentage of HCV in older age group such as age more than 60 years when considered to the total participants. HCV percentage was also high among older diabetic participants as suggested

Table 5. Association between Demographic Data and HCV

Demographic data		Anti-HCV positive (N=13)	Anti-HCV negative (N=621)	P
Age	10-20 years	0 (0.0%)	19 (100%)	0.60
	21-30 years	1 (0.9%)	115 (99.1%)	
	31-40 years	1 (0.9%)	114 (99.1%)	
	41-50 years	3 (2.2%)	133 (97.8%)	
	51-60 years	5 (3.0%)	165 (97.0%)	
	>60 years	3 (3.9%)	75 (96.1%)	
Gender	Male	7 (2.4%)	281 (97.6%)	0.58
	Female	6 (1.7%)	340 (98.3%)	
Marital status	Single	1 (0.9%)	104 (99.1%)	0.70
	Married	12 (2.3%)	517 (97.7%)	
Education level	Non-educated	4 (3.0%)	131 (97.0%)	0.67
	School-education	4 (1.6%)	247 (98.4%)	
	University-education	5 (2.0%)	243 (98.0%)	

Table 6. HCV Prevalence Among Diabetic and Non-Diabetic Participants

Diseases		Anti-HCV positive(N=13)	Anti-HCV negative(N=621)	P	Odds ratio	95% CI
Diabetes Mellitus	Yes	9 (2.5%)	347 (97.5%)			
	No	4 (1.4%)	274 (98.6%)	0.40	1.77	0.54 -5.83

by studies conducted in Dammam and Egypt.[1,57] A study conducted in central region of Yemen also revealed that there was increasing in seropositivity of HCV with older age.[56]

This study found that there is no significant association between HCV and type of DM, as previously determined in Dammam city which found that 15% of type 1 diabetic patients had HCV compared to 35% of patients with type 2 diabetic who had HCV.[1] A study conducted in Pakistan showed that out of 100 diabetic participants, only 36 had HCV seropositivity and all of them had type 2 DM.[53] Furthermore, a following study in the same country found strong relationship between HCV and type 2 DM.[58]

The present study found that the association between duration of DM and HCV was not statistically significant. A study conducted in

Table 7. Diabetes Mellitus Profile and HCV

General health		Anti-HCV positive (N=13)	Anti-HCV negative (N=621)	P
Type of Diabetes Mellitus	Diabetes Mellitus type1	0 (0.0%)	68 (100.0%)	0.21
	Diabetes Mellitus type2	9 (3.1%)	279 (96.9)	
Type of medication	Oral	7 (3.1%)	215 (96.9%)	0.71
	Insulin injection	2 (2.4%)	81 (97.6%)	
	Combination of both	0 (0.0%)	43 (100.0%)	
	Other	0 (0.0%)	2 (100.0%)	
Duration of Diabetes Mellitus	< 5 years	4 (3.2%)	121 (96.8%)	0.44
	5-10 years	4 (4.1%)	94 (95.9%)	
	11-20 years	1 (1.0%)	99 (99.0%)	
	>20 years	0 (0.0%)	33 (100.0%)	

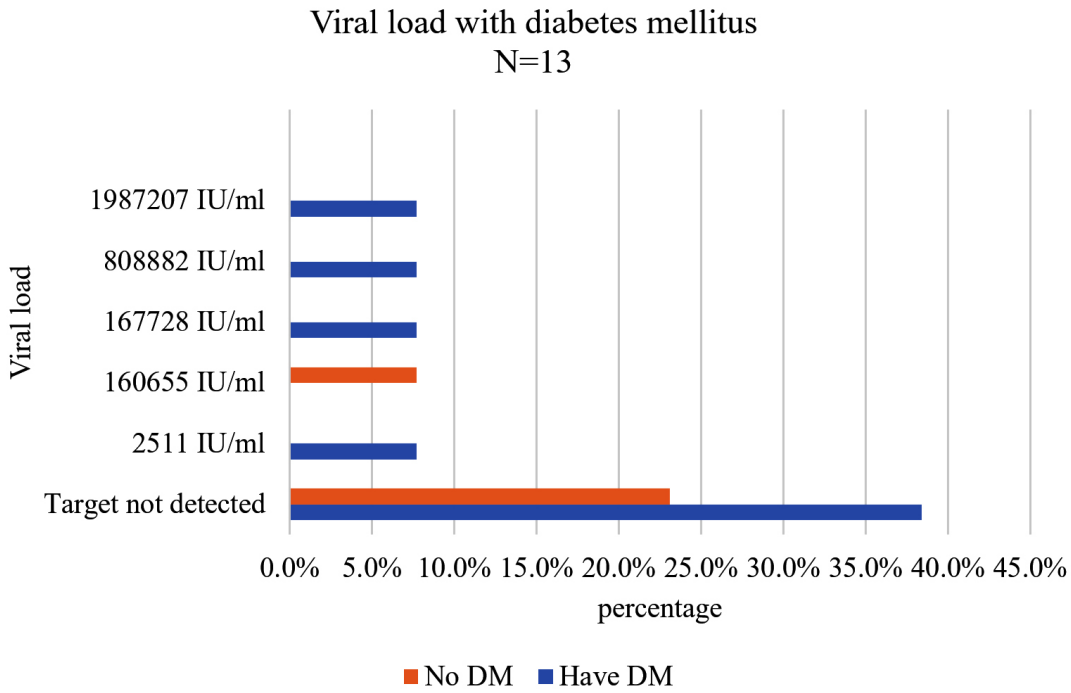

Figure 7. Comparative study between Viral Load with Diabetes Mellitus. Including target not detected, and target detected but with different viral loads

Table 8A. Association Between HCV and Behavioural Factors

Behavioural Factors		Anti-HCV positive (N=13)	Anti-HCV negative (N=621)	P
Blood transfusion	Yes	4 (4.7%)	81 (95.3%)	0.08
	No	9 (1.6%)	540 (98.4%)	
Haemodialysis	Yes	0 (0.0%)	10 (100.0%)	1.00
	No	13 (2.1%)	610 (97.9%)	
Tattooing	Yes	0 (0.0%)	13 (100.0%)	1.00
	No	13 (2.1%)	608 (97.9%)	
Surgery	Yes	6 (1.8%)	336 (98.2%)	0.58
	No	7 (2.4%)	285 (97.6%)	
Times of surgery	Once	4 (2.0%)	191(98.0%)	0.75
	Twice	1 (1.2%)	79 (98.8%)	
	Three times	1 (3.1%)	31 (96.9%)	
	>three times	0 (0.0%)	35 (100.0%)	
Hospitalization	Yes	11 (2.5%)	435 (97.5%)	0.36
	No	2 (1.1%)	186 (98.9%)	
Times of hospitalization	Once	6 (2.8%)	208 (97.2%)	0.77
	Twice	1 (1.0%)	94 (99.0%)	
	Three times	2 (3.4%)	57 (96.6%)	
	>Three times	2 (2.6%)	76 (97.4%)	
Hijama	Yes	7 (3.0%)	223 (97.0%)	0.24
	No	6 (1.5%)	398 (98.5%)	

Table 8B. HCV and Behavioural Factors

Behavioural factors		Anti-HCV positive (N=13)	Anti-HCV negative (N=621)	P
Times of Hijama	Once	5 (4.3%)	111 (95.7%)	0.75
	twice	1 (2.0%)	49 (98.0%)	
	Three times	1 (3.4%)	28(96.6%)	
	>three times	0 (0.0%)	35 (100.0%)	
IV Drugs	Yes	0 (0.0%)	13 (100.0%)	1.00
	No	13 (2.1%)	608 (97.9%)	
Sharing Personal Items	Yes	0 (0.0%)	58 (100.0%)	0.62
	No	13 (2.3%)	563 (97.7%)	

Dammam, Saudi Arabia has shown that 85% of HCV cases were with duration of more than 5 years of diabetes mellitus, compared to 15% in those with equal or less than 5 years. The association was significant between chronicity of diabetes mellitus and HCV[1]. However, a previous study showed that the majority of patient with HCV seropositive had less than 5 years duration of DM.[53]

There is an evidence that the insulin users are more prone to acquire infection since the unsafe injection and contaminated equipment's may lead to the infection, however this study showed no significant association between insulin injection and HCV. The percentage of anti-HCV was lower in insulin users compared to participants taking oral medication. A study conducted in France found no difference in diabetic participants with seropositivity for HCV comparing with the mode of treatment, being 62.5% for oral agents, 37.5% for insulin treatment.[59] However, a recent

Table 9. Association Between ALT and HCV

ALT	Anti-HCV positive (N=9)	Anti-HCV negative (N=401)	P
Normal	8 (2.0%)	387 (98.0%)	0.28
Elevated	1 (6.7%)	14 (93.3%)	

Table 10. Association Between AST and HCV

AST	Anti-HCV positive (N=10)	Anti-HCV negative (N=408)	P
Normal	8 (2.0%)	388 (98.0%)	0.09
Elevated	2 (9.1%)	20 (90.9%)	

Table 11. Liver Function Tests and Blood Glucose Level in HCV Positive Cases

Anti-HCV Positive	ALT	AST	HbA1c	Viral load
1.	53 U/L	31 U/L	6.50%	Target not detected
2.	83 U/L	76 U/L	9.30%	1987207 IU/ml
3.	26 U/L	29 U/L	7.70%	Target not detected
4.	36 U/L	32 U/L	6.90%	808882 IU/ml
5.	-	23 U/L	7.20%	Target not detected
6.	-	-	-	160655 IU/ml
7.	24 U/L	17 U/L	-	Target not detected
8.	38 U/L	34 U/L	5.60%	167728 IU/ml
9.	-	-	-	Target not detected
10.	-	-	-	Target not detected
11.	28 U/L	21 U/L	-	Target not detected
12.	33 U/L	54 U/L	5.80%	2511 IU/ml
13.	12 U/L	14 U/L	-	Target not detected

study revealed a higher infection among insulin users 65% compared to those with non-insulin treatment 35%.[1]

No significant association between sharing personal item, tattooing, blood transfusion, hospital admission and surgical operation, IV drug use, hijama and HCV was determined in the present study. A recent study also showed a non-significant association between surgery and blood transfusion with HCV.[52] However, a previous investigator found a significant association between most of these behavioural factors and HCV like sharing personal item, tattooing and blood transfusion, while dialysis, surgery, hospital admission had non-significant association with HCV. Moreover, a higher number of operation and hospital admission were found to have significant association with HCV.[1] Furthermore, a study conducted in Nile delta showed that the risk factors like blood transfusion and surgeries were significantly associated with HCV seropositivity when considered people with age of more than 20 years.[60] However, another study showed non-significant association between IV drug, sharing sharp item and hijama by health care worker with HCV, while a significant association between tattooing and hijama by people with HCV was found.[61]

No significant association was found between transaminase and HCV, which was unlike to the study conducted in Dammam city, showing the elevation of transaminases were a predictor for HCV.[1] A previous study in Pakistan found that high ALT levels were in associations with HCV seropositivity in diabetic participants.[53]

CONCLUSION

The present study shows a positive correlation between HCV and diabetes mellitus. Demographic characteristic like gender, had a significant influence on HCV and DM status. Different behavioral factors, however, had no significant impact on acquiring HCV infection. Further investigations are required to determine whether the HCV infection can lead to DM or

vice versa. A temporal relationship between HCV and DM needs to be established with the help of prospective studies. This study recommends that a good awareness about increasing HCV incidence and preventive control measures in the region need to be performed. Future screening of HCV among patients suffering from diabetes mellitus and vice versa is also highly recommended. Further study is required to find the prevalent genotype among diabetic patients in Qassim region.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS' CONTRIBUTION

MHA, PMS, UMI, AA and KA designed the experiments. MHA, HAAH and TAA performed the experiments. MHA, PMS, UMI and FA analysed the data. MHA, PMS, UMI, AA and KA wrote and revised the manuscript. All authors read and approved the final manuscript for publication.

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DATA AVAILABILITY

All datasets generated or analysed during this study are included in the manuscript.

ETHICS STATEMENT

This study was approved by the Institutional Ethics Committee and Regional Research Ethics Committee with registration N0. H-04-Q-001.

INFORMED CONSENT

Written informed consent was obtained from the participants before enrolling in the study.

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