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Risk Determinants to Hepatitis C Virus and Malaria Co-infection in Patients Attending Federal Medical Centre Lokoja, Nigeria

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Abstract: Hospital-based investigation was conducted at Federal Medical Centre, Lokoja, Nigeria to establish the seroprevalence of HCV and Malaria co-infection and their risk determinants. Serum samples from 250 subjects were assayed for the presence of antibodies to HCV, using a third generation Enzyme Linked Immunosorbent Assay and malaria parasite using Giemsa reagent. The seroprevalence of HCV and malaria, HCV alone and malaria alone in the subjects were 2.0%, 2.8% and 25.2% respectively. The prevalence of HCV was higher in males (6, 2.4%) than the females (1, 0.4%) while the prevalence of malaria was higher in females (37, 14.8%) than males (26, 10.4%). Analyses of demographic factors of the subjects showed that HCV is statistically significant with level of education, share of personal care items and body piercings (i.e. tattoos, tribal marks or both) ($p<0.05$), while malaria is statistically significant with blood transfusion ($p<0.05$). There was significance ($p<0.05$) in the mean values of ALT and AST in subjects with co-infection compared with subjects with malaria alone. The same trend was observed for subjects with malaria alone compared with subjects without HCV and malaria infections. We advocates that measures encouraging personal and environmental hygiene should be encouraged and blood transfusion rendered safe.

Key words: HCV · Malaria · Dual infections · ELISA · Risk factors

INTRODUCTION

Hepatitis C virus is the causative agents of Hepatitis C virus infection and it infects the liver [1]. Hepatitis C virus (HCV) is a small (55-65nm in size), enveloped, positive-sense single-stranded RNA virus of the family *Flaviviridae* [1]. Infection is often asymptomatic but once established, chronic infection can lead to scarring of the liver (fibrosis) and advanced scarring (cirrhosis) which is generally apparent after many years [2]. Sometimes, those with cirrhosis progress to develop liver failure or other complications of cirrhosis, including liver cancer [2]. About 170 million people are infected with HCV worldwide [3, 4]. It has been detected in semen [5] and saliva [6]. The risk of vertical transmission is 6% and 25% in mothers observed only to be HCV positive and in those who are HCV/HIV positive respectively [7].

Malaria is a life threatening parasitic disease transmitted by female anopheles mosquitoes. It is the most highly prevalent tropical disease, recording high morbidity and mortality with high economic and social impact [8]. Hepatitis C virus is an agents of hepatitis known to be transmitted by blood and blood products [9]. Over two decades ago, screening for HCV markers in blood donors was introduced, however, transfusion-associated hepatitis due to HCV has continued to occur [10]. Co-endemic falciparium malaria and acute hepatitis C have been reported in Southeast Asia, Africa and the tropical America. Both HCV and malaria represent key threats to public health (WHO). Today, malaria remains

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the most common cause of morbidity and mortality in Nigeria despite remarkable achievements by government and key stakeholders.

The magnitude globally of dual infections with malaria is not yet exactly defined, however, it may be common in subjects infected with Hepatitis C Virus (HCV) in developed countries. Previous reports mainly from industrialized countries have shown that HCV is almost exclusively limited to intravenous drug abusers, haemophiliacs [11] and homosexuals [12]; groups believed to be uncommon in the West African region. In the West African region, studies of malaria and HCV have become necessary because of the emerging evidence of a high HCV prevalence [13, 14] along with a concurrent malaria endemicity [15].

In Lokoja, baseline data on HCV prevalence and the risk factors are lacking. To the best of our knowledge studies on HCV and malaria co-infections in Nigeria have not been reported. This study therefore aimed to contribute generally to our understanding of the natural history of co-infection between HCV and malaria.

MATERIALS AND METHODS

Study Area: This study was carried out in Lokoja, the capital of Kogi state in North Central Nigeria. It is located between Latitude 6°31' N and 851'N and Longitude 551' E and 8 00'E [16].

Subjects: A total of 250 subjects within the age group 1-60 years were enrolled into this study. The participants were recruited from patients attending the G.O.P.D of Federal Medical Centre, Lokoja, Nigeria. They gave consent voluntarily, after a detailed explanation of the purpose and procedure of the study. Ethical approval was obtained from the Hospital Ethical Board. Each participant completed a structured questionnaire to assess demographic characteristics, medical history, sexual and social behaviours.

Specimen Collection: Five milliliters of whole blood was collected by clean venepuncture from the cubital vein of each subject into two specimen bottles (anticoagulant bottles, containing K2EDTA for malaria parasite test and plain bottles for the Hepatitis C surface antigen screening).

HCV ELISA Serology: Antibody to HCV was detected using a commercial third-generation ELISA from DIA.PRO. Diagnostic Bioprobes Srl (via Columella no 31-Milano-Italy). Testing was carried out according to the manufacturer's instructions. This test is based on the use of a solid based prepared with solid antigens; two recombinant proteins produced by *Escherichia coli* from clones selected in the nonstructural area of the hepatitis C virus genome (NS3 and NS4), two peptides coded by capsid area of the hepatitis C virus genome. Detection is with the goat anti-human IgG antibody purified by affinity chromatography and coupled to peroxidase.

Steps in the performance of the test include: i) the test sera and the control sera were added to the wells. If the antibodies to HCV were present, they would bind to the antigens fixed on the solid phase, ii) the peroxidase labeled antibodies to human IgG was added after a washing step. They in turn bound to the specific antibodies captured on the solid phase, iii) after removal of the unbound enzymatic conjugate, the antigen-antibody complex was revealed by addition of substrate, iv) after the reaction has been stopped, the absorbance values were read at 492/620nm. The absorbance measured for a sample allowed the presence or absence of antibody to HCV to be determined. The colour intensity is proportional to the quality of antibody to HCV bound on the solid phase. The absorbance of the positive control was 0.900 - 2.500 and the negative control was < 0.200. The presence or absence of antibodies to HCV is determined by comparing for each sample the recorded absorbance with that of the cut-off value. Samples with an optical density less than the cut-off value are considered to be negative. Samples with an optical density higher than or equal to the cut-off value are considered to be positive.

Giemsa Staining Method for Malaria Parasite Detection: A drop of whole blood was dropped on a clean glass slide and then mixed using a glass slide to make a thick smear. The thick smear was fixed in absolute methanol for one minute. Giemsa stain was then added to the slide and left for thirty minutes. The slide was then tilted to get rid of the stain and the slide washed in running tap. The underneath of the slide was finally wiped clean and air-dried. Immersion oil was then added to each slide and viewed under *40 magnification of microscope.

Liver Function Test (LFT): The procedure as described by Reitman and Frankel was employed for the assay of aspartate aminotransaminase and alanine aminotransaminase activities [17].

Statistical Analysis: The prevalence of each infection (HCV and Malaria) was determined from the proportion of seropositive individuals in the total population under consideration and expressed as a percentage. The chi-square test was employed to determine the relationships between demographic and risk factors. P values < 0.05 were considered to be statistically significant.

RESULTS AND DISCUSSION

The findings from this study further confirm the presence of hepatitis C infection in Nigeria [18, 19]. A prevalence of 2.8% was established in the subjects sampled (Table 1). However, when compared with the report of Halim and Ajayi [20] who recorded a prevalence of 5.8-12.3% in Nigeria and that reported by Udeani *et al.* [21] with a prevalence of 13.6% in Jos, Nigeria, it is evident that the prevalence rate of HCV in Lokoja is low. A seroprevalence of 2.0% was observed in the subjects for HCV and malaria co-infection. The occurrence of higher prevalence of malaria infection in females may be as a result of reduced immunity coupled with pregnancy observed in some of the subjects. Pregnancy appears to interfere with the immune processes in malaria which sometimes alters immune response [15]. In highly endemic malarious communities where semi-immune adults usually have substantially acquired resistance to local strains of plasmodia, the prevalence of clinical malaria is higher and its severity greater in pregnant women than non-pregnant women [22].

Demographic factors of subjects and their HCV/Malaria status data showed that HCV is common among the uneducated, people who have received unscreened blood, those who share personal care items and people with various body piercings (i.e. tattoos, tribal marks or both tattoos and tribal marks) while malaria could be transmitted through blood transfusion (Tables 1-6).

A total of 118 (47.2%) males and 132 (46.0%) females were recruited into this study (Table 1). Males had a higher seropositivity of 2.4% than the females with 0.4% in agreement with the report by Alter *et al.* [23] that males seem to be more predisposed to HCV than females. In another work by Mboto *et al.* [24], men accounted for 71% of the infections detected with a comparatively higher prevalence rate than in females. The higher seropositivity in male subjects could be due to the fact that they are more sexually active [25].

The highest seropositive values of 3 (1.2%) and 4 (1.6%) were found among subjects in the age group of 21-30years and 31-40years (Table 1). This is similar to values reported by McQuillan *et al.* [25] with the highest HCV prevalence being found among persons aged 20-49years and Nwankiti *et al.* [26] with the highest HCV prevalence being found among persons aged 18-37 years.

Table 1: Seroprevalence of Hepatitis C virus infection in relation to the sex, age, blood transfusion, alcohol consumption status and HIV status of the patients

Demographic Characteristics	Number (%)	N (%) Positive	p-value
Sex			0.380
Male	118(47.2%)	6(2.4%)	
Female	132(52.8%)	1(0.4%)	
Age			0.461
11-20Yrs	20(8.0%)	0(0.0%)	
21-30Yrs	58(23.2%)	3(1.2%)	
31-40Yrs	115(46.0%)	4(1.6%)	
41-50Yrs	44(17.6%)	0(0.0%)	
51-60Yrs	13(5.2%)	0(0.0%)	
Blood Transfusion			0.000
Yes	16(6.4%)	3(1.2%)	
No	234(93.6%)	4(1.6%)	
Alcohol Consumption			0.931
Yes	33(13.2%)	1(0.4%)	
No	217(86.8%)	6(2.4%)	
HIV Status			0.049
Positive	5(2.0%)	0(0.0%)	
Negative	245(98.0%)	7(2.8%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

Table 2: Seroprevalence of Hepatitis C virus infection in relation to multiple sex partners, recent change in sexual partners, family type and sexual route of the patients

Demographic Characteristics	Number (%)	Number (%) Positive	p-value
Multiple Sex Partners			0.013
Yes	31(12.4%)	3(1.2%)	
No	219(87.6%)	4(1.4%)	
Recent Change in Sexual Partners			0.223
Yes	33(13.2%)	2(0.8%)	
No	217(86.8%)	5(2.0%)	
Family Type			0.572
Monogamous	228(91.2%)	6(2.4%)	
Polygamous	21(8.4%)	1(0.4%)	
Missing system	1(0.4%)	0(0.0%)	
Sexual Route			0.989
Vaginal	235(94.0%)	7(2.8%)	
Anal	1(0.4%)	0(0.0%)	
Vaginal and Fisting	2(0.8%)	0(0.0%)	
Vaginal, Anal and Fisting	1(0.4%)	0(0.0%)	
Missing system	11(4.4%)	0(0.0%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

Table 3: Seroprevalence of Hepatitis C virus infection in relation to sex type, body piercings, shared personal care items and the educational levels of the patients

Demographic Characteristics	Number (%)	N (%) Positive	p-value
Sex Type			0.764
Heterosexual	240(96.0%)	7(2.8%)	
Others	3(1.2%)	0(0.0%)	
Missing system	7(2.8%)	0(0.0%)	
Body Piercings			0.000
Tribal Marks	69(27.6%)	5(2.0%)	
Tattoos	2(0.8%)	0(0.0%)	
Tribal Marks and Tattoo	1(0.4%)	1(0.4%)	
No mark	178(71.2%)	1(0.4%)	
Shared Personal Care Items			0.006
Razors	29 (11.6%)	3(1.2%)	
Pedicuring Equipments	1 (0.4%)	0(0.0%)	
Weaving Needle	4 (1.6%)	0(0.0%)	
Razors and Cuticle Scissors	10 (4.0%)	2(0.8%)	
Manicuring and Pedicuring Equipments	1 (0.4%)	0(0.0%)	
Manicuring, Pedicuring and Weaving Equipments	1 (0.4%)	0(0.0%)	
Nil	203(81.2)	2(0.8%)	
Education Level			0.000
Quranic Only	1 (0.4%)	0(0.0%)	
No formal education	24 (9.6%)	6(2.4%)	
Primary education	16 (6.4%)	0(0.0%)	
Secondary education	57 (22.8%)	0(0.0%)	
Tertiary education	152 (60.8%)	1(0.4%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

Table 4: Seroprevalence of Malaria infection in relation to the sex, age, blood transfusion status, alcohol consumption status and HIV status of the patients

Demographic Characteristics	Number (%)	N (%) Positive	p-value
Sex			0.701
Male	118(47.2%)	26(10.4%)	
Female	132(52.8%)	37(14.8%)	
Age			0.300
11-20Yrs	20(8.0%)	7(2.8%)	
21-30Yrs	58(23.2%)	14(5.6%)	
31-40Yrs	115(46.0%)	27(10.8%)	
41-50Yrs	44(17.6%)	14(5.6%)	
51-60Yrs	13(5.2%)	1(0.4%)	
Blood Transfusion			0.049
Yes	16(6.4%)	8(3.2%)	
No	234(93.6%)	55(22.0%)	
Alcohol Consumption			0.466
Yes	33(13.2%)	9(3.6%)	
No	217(86.8%)	54(21.6%)	
HIV Status			0.574
Positive	5(2.0%)	2(0.8%)	
Negative	245(98.0%)	61(24.4%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

Table 5: Seroprevalence of Malaria infection in relation to multiple sex partners, recent change in sexual partners, family type and sexual route of the patients

Demographic Characteristics	Number (%)	Number (%) Positive	p-value
Multiple Sex Partners			0.493
Yes	31(12.4%)	9(3.6%)	
No	219(87.6%)	54(21.6%)	
Recent Change in Sexual Partners			0.420
Yes	33(13.2%)	10(4.0%)	
No	217(86.8%)	53(21.2%)	
Family Type			0.349
Monogamous	228(91.2%)	55(22.0%)	
Polygamous	21(8.4%)	7(2.8%)	
Missing system	1(0.4%)		
Sexual Route			0.654
Vaginal	235(94.0%)	58(23.2%)	
Anal	1(0.4%)	0(0.0%)	
Vaginal and Fisting	2(0.8%)	1(0.4%)	
Vaginal, Anal and Fisting	1(0.4%)	0(0.0%)	
Missing system	11(4.4)	0(0.0%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

Table 6: Seroprevalence of Malaria infection in relation to sex type, body piercings, shared personal care items and educational levels of the patients

Demographic Characteristics	Number (%)	N (%) Positive	p-value
Sex Type			0.802
Heterosexual	240(96.0%)	60(24.0%)	
Others	3(1.2%)	0(0.0%)	
Missing system	7(2.8%)		
Body Piercings			0.464
Tribal Marks	69(27.6%)	19(7.6%)	
Tattoos	2(0.8%)	1(0.4%)	
Tribal Marks and Tattoo	1(0.4%)	1(0.4%)	
No marks	178(71.2%)	42(16.8%)	
Shared Personal Care Items			0.606
Razors	29 (11.6%)	7(2.8%)	
Pedicuring Equipments	1 (0.4%)	1(0.4%)	
Weaving Needle	4 (1.6%)	3(1.2%)	
Razors and Cuticle Scissors	10 (4.0%)	5(2.0%)	
Manicuring and Pedicuring Equipments	1 (0.4%)	0(0.0%)	
Manicuring, Pedicuring and Weaving Equipments	1 (0.4%)	1(0.4%)	
Nil	203(81.2%)	46(18.4%)	
Education Level			0.083
Quranic Only	1 (0.4%)	1(0.4%)	
No formal education	24 (9.6%)	9(3.6%)	
Primary education	16 (6.4%)	5(2.0%)	
Secondary education	57 (22.8%)	15(6.0%)	
Tertiary education	152 (60.8%)	33(13.2%)	

p-value < 0.05= statistically significant

p-value > 0.05= not statistically significant

The seropositivity recorded in these groups may be as a result of their exposure to contaminated blood through transfusion. Also the observation of HCV antibodies in person aged 21-40years may be suggestive of sex as a possible transmission mode. This is because intravenous substance abuse, which is the principal route of transmission of the virus in most developed countries [11, 12, 27] is a rare event in Nigeria.

Sixteen (16) of the subjects have had blood transfusion while the other 234 (93.6%) subjects have not had blood transfusion (Table 1). Blood transfusion materials and processes are of great concern since it is one of the main routes by which Hepatitis C virus infection is transmitted and this may involve the use of unscreened blood samples being transfused in hospitals [28]. In this study, there was significance between Hepatitis C virus infection and blood transfusion ($p<0.05$).

One (1) subject positive for HCV responded yes for alcohol consumption, the other 6 subjects positive for HCV do not consume alcohol, 32 subjects negative for HCV consume alcohol and 211 subjects negative for HCV also do not consume alcohol. There was no significance between alcohol consumption and Hepatitis C virus infection ($p>0.05$) (Table 1). Alcohol intake is not directly a risk factor to HCV. However, it has been documented that there exists a synergy between HCV and alcohol. Increased alcohol consumption increases the risk of fibrosis leading to carcinoma [29]. Higher hepatic iron concentration have been reported in alcoholic HCV infected patients than non-alcoholic HCV positive patients. High iron concentration increases the rate of HCV replication thereby playing an important role in liver damage.

A total of 5 (2.0%) subjects are positive for HIV while the other 245 (98.0%) are negative for HIV (Table 1). In a work done by Mboto *et al.* [24], the co-infection of HIV and HCV was observed in nine out of 1500 (0.6%) participants with men accounting for 7 (77.7%) of the cases. In this study, there was significance between HCV and HIV status of the patients ($p<0.05$). This is in consonance with Mboto *et al.* [24] who also reported that there was significance between HIV and HCV.

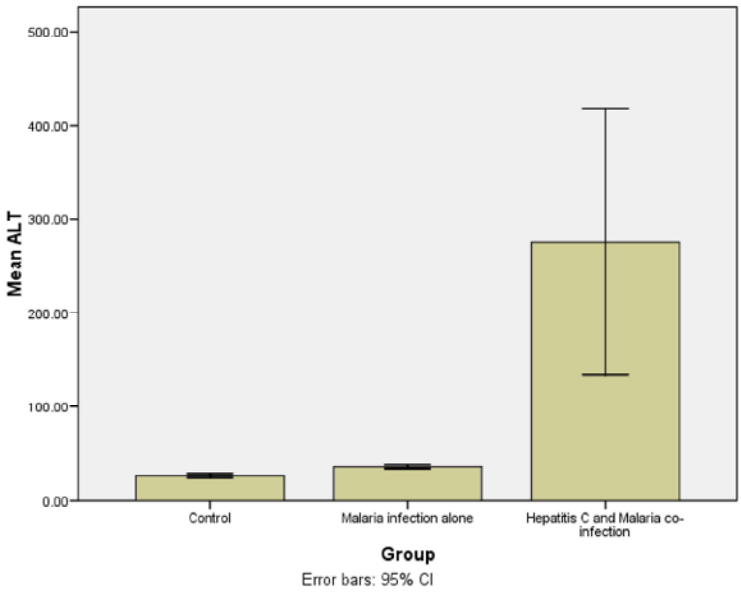

Fig. 1: Specific Activity (U/mg protein) of ALT of subjects.

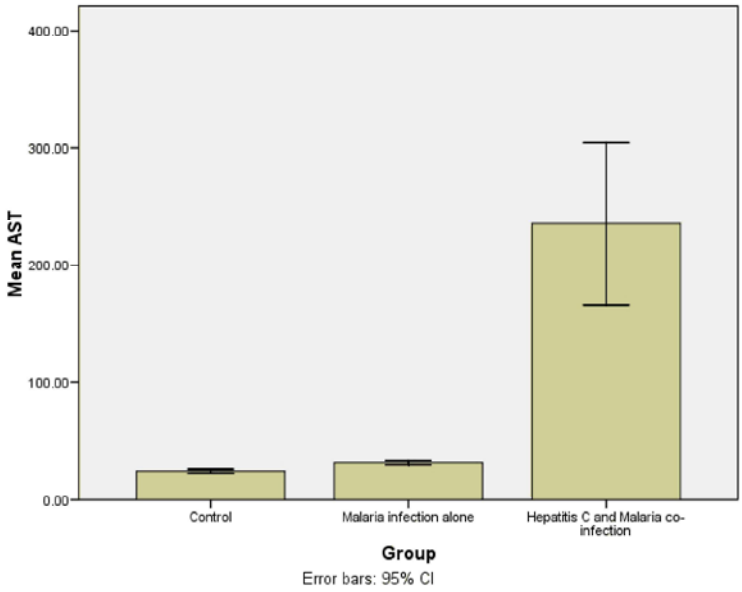

Fig. 2: Specific Activity (U/mg protein) of AST of subjects.

An important issue is the interaction between HIV and HBV or HCV. HIV/HBV and HIV/HCV co-infection have a negative impact on the liver disease caused by these viruses [30, 31]. HCV have been reported to accelerate the evolution and progression of liver disease in HIV-infected individuals [31, 32].

A total of 31 (12.4%) subjects have multiple sexual partners while 219 (87.6%) subjects do not have multiple sexual partners (Table 2). Sexual route of transmission of Hepatitis C virus has also been reported by Oni *et al.* [33]. In this study, there was significance between HCV and multiple sexual partners ($p<0.05$). This is in accordance with the report of Mboto *et al.* [24].

A total of 33 (13.2%) subjects also have recent change in sexual partners (Table 2). There was no significance between HCV and recent change in sexual partners ($p>0.05$). A total of 228 (91.2%) subjects have monogamous families, 21 (8.4%) subjects operates polygamous families and 1 subject did not respond. There was no significance between HCV and family type

(p>0.05). This is noteworthy since about 92% of the subjects have monogamous families and when considering the proportion of them with multiple sexual partners (12.4%), it was quite high and also the proportion of them who have recent change in sexual partners (13.2%) was high. This could be due to the high levels of education of the subjects, as it is believed that the higher the level of education, the more the exposure risk of persons to sexual adventures and fun. This is in agreement with the report of Oni *et al.* [33].

A total of 235 (94.0%) subjects have vaginal penetrative sex, 1 (0.4%) has anal penetrative sex, 2 (0.8%) have vaginal penetrative sex and fisting, 1 subject has vaginal, anal and fisting, while 11 (4.4%) were indifferent. A total of 240 (96.0%) subjects reported that they have heterosexual relationships; while 3 (1.2%) reported that they have had homosexual relationships. However, there was no significance between HCV and sex type of the patients (p>0.05) (Tables 2 and 3). This findings is in consonance with the work of Collin *et al.* [34]. Also, sexual practices in male homosexual population have been associated with HCV infection [35].

Of the total 250 subjects recruited for this study, 178 (71.2%) have no marks on their body, 69 (27.6%) have only tribal marks, 2 (0.8%) subjects have only tattoos while 1 (0.4%) subject has both tribal mark and tattoo (Table 3). This is of great importance because scarification; a common practice in our environment has been found to be an important factor in the transmission of HCV [36, 37, 38]. During scarification, non-sterile equipments are often used by quacks thereby aiding transmission. In this study, there was correlation between HCV and body piercings (p<0.05). Only one (1) subject positive for HCV has tribal marks, 177 subjects negative for HCV did not have tribal marks, 64 subjects negative for HCV have tribal marks, 2 subjects negative for HCV have tattoos, 1 subject with HCV has both tattoo and tribal mark while 5 subjects positive for HCV have tribal marks. There was significant correlation (p<0.05) between HCV and body piercing. The subjects positive for HCV in this study could also have been infected through the use of contaminated instrument during tattoo or body piercing [39]. Since most of the subjects positive for HCV are from the age group of 20-40years constituting the workforce (productive age group) of the nation, it could lead to loss of man power especially when they suffer acute illness and are probably hospitalized.

A total of 203 (81.2%) of the subjects do not share any personal care item, 29 (11.6%) share only razor blades, 1 (0.4%) share pedicuring equipments, 4 (1.6%) subjects share weaving needle, 10 (4.0%) subjects share both razor blades and cuticle scissors, 1 (0.4%) subject shares both manicuring and pedicuring equipments (Table 3). The transmission of HCV through personal care procedures has not been well studied. However, the California Department of Health Services had previously reported HCV seropositivity in a woman whose only risk factor for acquiring the virus was regular visits to a nail salon [40]. Also, transmission of malaria through needle-stick injuries among health care workers or due to needle sharing among drug addicts have been previously reported [41, 42]. These personal care items could serve as fomites for Hepatitis C virus [28]. Significant correlation was observed between HCV and shared personal care items (p<0.05).

A total of 1 (0.4%) subject had only Quranic education, 24 (9.6%) subjects have no formal education, 16 (6.4%) subjects have primary education, 57 (22.8%) subjects have secondary education and 152 (60.8%) have tertiary education (Table 3). The higher the level of education, the more likely the sexual adventure which often times involve multiple partners [33]. There was significant correlation between HCV and the level of education (p<0.05). This result is in consonance with the report of Oni *et al.* [33]. However, it is contrary to the findings of Todd *et al.* [43] which reported that participants with HCV infection were less likely to be educated or married and have higher income.

In this study, malaria was found to be common in females (37; 14.8%) than in males (26; 10.4%) and no significant correlation between malaria and sex (p>0.05) was observed. Malaria infection was also found in 7(2.8%) of subjects in the age group 11-20years, 14 (5.6%) in 21-30 years group, 27 (10.8%) in 31-40years group, 14 (5.6%) in 41-50years group and 1 (0.4%) in 51-60years group. However, there was no significant correlation between malaria and age group (p>0.05) (Table 4). Previous reports have shown that malaria is often not sex-disaggregated as those in highest risk biologically are infants and young children, pregnant women, non-immune people (such as travelers, labourers and populations moving from low-transmission to high transmission areas) and people living with HIV/AIDS. Available evidence suggested that given equal exposure, adult men and women are equally vulnerable to malaria infection, except for pregnant women who are at greater risk of severe malaria in most endemic areas [44].

Eight (8) subjects with no malaria parasite have had blood transfusion, 8 subjects with malaria parasite have

also had blood transfusion, 179 subjects without malaria parasite have not had blood transfusion and 55 subjects with malaria parasite have not had any blood transfusion (Table 4). Results showed that there was significant correlation between malaria and blood transfusion ($p<0.05$). First reported in 1911, transfusion malaria still remains one of the most common transfusion-transmitted infections today [41, 45]. The risk of acquiring transfusion malaria is very low (1 case per 4 million) in non-endemic countries such as the United States, whereas in the endemic countries like Nigeria, it is much higher (>50 cases per million donor units) [45, 46].

Only two (2; 0.8%) subject were positive for both malaria and HIV/AIDS while 61 (24.4%) subjects were positive for only malaria infection. No significant correlation ($p>0.05$) was observed between malaria and HIV status of the subjects (Table 4). Women with dual HIV and malaria infection are at particular risk of severe anaemia and adverse birth outcome. One study in Kenya reported that HIV seropositive women with malaria were twice more likely to have anaemia than HIV seronegative women with or without malaria [47].

In this study, malaria did not show significant association ($p>0.05$) with these risk factors; alcohol consumption, multiple sexual partners, recent change in sexual partners, family type, sexual route, sex type, body piercings and shared personal care items. Relationship between malaria and educational level revealed that only 1 (0.4%) subject had Quranic education, 9 (3.6%) had no formal education, 5 (2.0%) had primary education, 15 (6.0%) had secondary education and 33 (13.2%) had tertiary education (Tables 4 - 6). Previous reports have suggested that the levels of education may also affect malaria treatment-seeking and prevention behaviours. A study in south-eastern Nigeria reported that higher levels of education were associated with improved knowledge and practices in relation to appropriate prevention and treatment strategies [48]. The result of this study did not agree with this view, as the most infected subjects were educated people, indicating that they could not be associated with improved knowledge and practices in relation to prevention and treatment strategies for malaria.

Analyses of ALT and AST levels in the subjects also showed significant difference ($p<0.05$) in malaria and HCV co-infection when compared with subjects with malaria alone. There was also significant difference ($p<0.05$) in ALT and AST of subjects with malaria and hepatitis C co-infections and subjects with malaria alone when compared with control subjects. Impaired hepatic function was found in subjects with malaria and it was more pronounced in subjects with malaria and hepatitis C dual infection. Our findings revealed that there was severe elevation of transaminases activity (alanine transaminase and aspartate transaminase) which could be an indicator of liver damage [49]. Results showed a >20 times increased in the level of ALT and AST in the patients with dual infections of hepatitis C virus and malaria parasite; a situation which occur usually in severe viral hepatitis, drug or toxin induced necrosis and circulatory shock [50, 51]. The patients with malaria infection alone also showed mild elevation of ALT and AST (>2 times). It has been reported that hepatic failure is associated with *P. falciparum* which causes local circulatory failure and centrilobular cellular damage [52, 53]. Since these enzymes are associated with the liver and red blood cells, the destruction of the liver and red blood cells triggers their release into circulation.

CONCLUSION

The low prevalence of HCV antibodies in subjects in this study does not take away the necessity of adopting measures that will ensure that practices common in this area; scarifications, tattoing, share of close personal care items, transfusion of improperly screened blood e.tc. are kicked against thereby leading to minimal risk of transmission. Malaria was observed to have significant correlation with blood transfusion but a number of other factors may also contribute to the maintenance of the vector and high malaria transmission. Identifiable among these are: ditches, gutters and other man-made temporary pools of water. The adoption of malaria control measures should be encouraged, these includes campaigns promoting the use of mosquito treated nets, maintenance of good personal and environmental hygiene. The discovery of a malaria vaccine will also go a long way in alleviating the negative effect in areas of high transmission. All these measures will help to reduce the risk of HCV and malaria dual infections in Nigeria.

Declaration of Interest: None.

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