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BRIEF ARTICLE

Epidemiological profiles of human immunodeficiency virus and hepatitis C virus infections in Malian women: Risk factors and relevance of disparities

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Abstract

AIM: To document the epidemiologic patterns and risk factors of human immunodeficiency virus (HIV) and hepatitis C virus (HCV) infections in Mali in order to develop prevention means for both diseases.

METHODS: Two prospective studies were conducted in Bamako in 2009 among 1000 pregnant women (*i.e.*, young women) who consulted six reference health centers, and in 2010, among 231 older women who attended general practice in two hospitals. Antibody tests and molecular analysis (performed only for HCV) were used to quantify the frequencies of both infections. The data were collected from patients recruited through a questionnaire. Transmission risk factors of both diseases were identified by univariate and multivariate analysis.

RESULTS: HCV seroprevalence was 0.2% for young and 6.5% for older women. HIV prevalence was similar in both populations (4.1% *vs* 6.1%). In older women, the analysis of risk factors highlighted an association between HCV infection and episodes of hospitalization ($P < 0.01$). The study did not show an association between HIV infection and the variables such as hospitalization, transfusion, tattoo, dental care, and endoscopy. A significant decrease of HIV seroprevalence was detected in young women who used condoms for contraception more than for other purposes ($P < 0.01$). By contrast, HIV seroprevalence was significantly increased in young women using condoms mainly to prevent sexual infections rather than for contraception ($P < 0.01$). No HCV/HIV coinfection was detected in our study.

CONCLUSION: Risk factors and epidemiologic data of HIV and HCV as well as the absence of co-infection strongly suggest epidemiological disparities between these diseases.

Key words: Hepatitis C virus; Human immunodeficiency virus; Epidemiology; Risk factors; Women; Mali; Bamako

Core tip: In Mali, hepatitis C virus (HCV) studies have been mostly conducted among specific populations such as blood donors, patients suffering from chronic hepatitis or hemodialysis patients. Studies on the extent and epidemiology of HCV infection in the general Malian population are not abundant. The present study demonstrates that the risk factors classically associated to HCV infection, such as transfusion, are not dominant in this African population. The data presented in this paper have important implications in designing effective prevention strategies for human immunodeficiency virus and HCV infections.

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INTRODUCTION

Human immunodeficiency virus (HIV) infection is propagated mainly through blood transfusion (before 1985), intravenous drug use, professional exposure in medical personnel, sexual transmission and mother-to-child transmission. Hepatitis C virus (HCV) contamination is also caused by intravenous drug use and blood transfusion (before 1991), while vertical transmission accounts for less than 5% of the cases and sexual transmission is exceptional[1]. Historically, HCV infection has developed in three waves: *via* medical care through needles and syringes reused without sterilization, *via* blood transfusion before 1991, and finally through intravenous drug injection or the sharing of straws for cocaine inhalation[2]. In industrialized countries, the risk of HCV transmission by blood transfusion is currently controlled by the measures taken to secure blood donation: clinical selection, screening of infectious markers among blood donors and application of viral inactivation processes. Drug addiction is now the major mode for transmission of HCV infection in industrialized countries[2]. The geographical distribution of HCV is variable, with areas of high prevalence such as Africa and Asia where the prevalence may exceed 10%, and low endemic regions such as North America or Western Europe with prevalence around 1%. The high prevalence of HCV infection in developing countries is mainly due to iatrogenic transmission occurred during injections in campaigns of treatment or mass vaccination. A well-known case is Egypt where campaigns of anti-schistosomiasis were undertaken from 1920 to 1980. HCV propagation still represents a major public health problem in developing countries in which high HCV prevalence is associated with suboptimal blood safety[2].

In countries where historically HCV epidemy has emerged early, there is already a notable increase of the incidence of hepatic complications. In Mali, HCV studies have been mostly conducted among specific populations such as blood donors, patients suffering from chronic hepatitis or hemodialysis patients[3-5]. Studies on the extent and epidemiology of HCV infection in the general Malian population are not abundant. The present study aims to document epidemiologic patterns, risk factors and modes of transmission shared by both diseases in Mali using the epidemiologic data previously published by our group[6].

MATERIALS AND METHODS

Patients

Two populations of Malian women were analyzed to characterize their serological status toward both HIV (screening and confirmation tests) and HCV [screening, serological confirmation, search for HCV-RNA by polymerase chain reaction (PCR) and genotyping]. Samples of serum and plasma were prepared from venous whole blood.

The first series included 1000 young women who attended antenatal clinics in the 6 health reference centers (named I to VI) located in Bamako. The second set consisted in 231 older women (over 50 years) attending the consultations of general medicine in two hospitals (Centre Hospitalier Mère-Enfant and CHU Gabriel Touré) located in Bamako. Patients with physical or mental condition precluding investigation as well as those treated with heparin (inhibitor of PCR) were excluded from the study. This work was carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This study was approved ethically under the reference number 08-0006/INRSP-CE (Ethical Committee of National Institute of Public Health) of Mali. All participating subjects remained anonymous and gave voluntarily informed consent.

Questionnaire on risk factors of HIV and HCV infections

A questionnaire was used to collect information about behaviours at risk or potentially at risk among all participants and the data were analyzed in order to identify risk factors for the transmission of both infections. Since Trypanosomiasis may interfere with HCV serology, it was searched for through specific questions allowing presumptive diagnosis[7]. To this end, the participants were asked whether they presented symptoms such as sleep problems, anorexia or skin rash.

The residence of the subjects was defined as follows: urban (municipalities of Bamako district or chief town of administrative region) or rural (areas outside both Bamako district and chief town of administrative region). Mali includes 8 administrative regions in addition to the Bamako district. The variables studied in the questionnaire were divided into two groups: (1) The sociodemographic and professional characteristics: age, parity, gravidity, marital status, occupation of the woman and the husband or partner, extent of knowledge of both HCV and HIV infections, use of condom (yes-no) and

Table 1 Demographic characteristics and clinical history among young and old women

Descriptive characteristics	Young women (≤ 50 yr)		Older women (> 50 yr)	
	n (%)	mean ± SD	*n* (%)	mean ± SD
Age (yr)	999	25.2 ± 6.3	231	62.1 ± 8.6
Sex (women)	1000 (100)		231 (100)	
Rural residence area	26 (2.6)		67 (29.1)	
Urban residence area	964 (97.4)		163 (70.9)	
Transfusion history	21 (2.1)		16 (7)	
Hospitalization history	137 (13.8)		76 (33.2)	
Knowledge of HIV status	577 (58.8)		35 (15.3)	
Knowledge of HCV status	16 (1.6)		11 (4.8)	
Condom use	217[1] (21.9)		N/I	
Condom use for ITS/HIV prevention	113 (52.1)			
Condom use for contraception	117 (53.9)			
Marital status				
Single	77 (7.7)		N/I	
Divorced	2 (0.2)		6 (2.6)	
Married	916 (91.9)		108 (47)	
Widowed	2 (0.2)		116 (50.4)	

[1]217 young women reported condom use; among them, 21 did not explain their motivation and 34 used it for contraception as well as for infections transmitted by sexual relation (ITS)/human immunodeficiency virus (HIV) prevention. N/I: Not implemented in old women (cultural context); HCV: Hepatitis C virus.

reason to use it, education (instruction level), residence (urban, rural), frequency of travel for husband or partner, frequency of travel for woman; and (2) Clinical history and clinical informations: knowledge of their HIV and/or HCV status before entering the study, parasitosis (Trypanosomiasis)[7], clinical history and medical treatments: heparin (PCR inhibitor), infibulation, hospitalization, transfusion, dialysis, dental care, fibroscopy, proctoscopy; socio-cultural practices: tattooing/scarification/piercing, excision, haircut visit of the husband or partner.

Screening and confirmation of infection with HIV and HCV

The HIV third generation rapid testing VIKIA 1/2 (Bio-Mérieux) was used for HIV screening. Positive screened samples were confirmed by using the INNO-LIA HIV I / II Score (Innogenetics)[6].

HCV mixed MONOLISA Ab/Ag Ultra test was used for both antibody and viral antigen detection in the serum or plasma of recruited patients. The results were analyzed in triplicates and samples found positive two or three times [*i.e.*, with test ratio (TR) ≥ 1] were confirmed by LIA HCV Score III v2 (Innogenetics). The results were interpreted according to the instructions given by the manufacturers. HCV samples confirmed positive by LIA were analyzed by molecular biology (HCV Cobas Monitor, Roche or Abbott Real Time HCV). Samples tested positive by Monolisa but negative by LIA and thus suspect of early infection were also analyzed by molecular methods. HCV genotyping was determined using Versant HCV Genotype Assay LiPA test from Siemens Healthcare Diagnostics[6].

Statistical analysis

Results are presented as mean ± SD (range) for continuous variables and as frequency (%) for categorical variables. Comparisons of categorical variables were assessed between groups using the χ^2 test. With HCV and HIV as dependent variables, risk factors were identified by univariate logistic regression. In the young women subpopulation (in which all variables were studied without restriction linked to gravidity status or cultural context), multivariate logistic regression was used. Results were considered significant at the 5% level of significance ($P < 0.05$). Calculations were performed using SAS version 9.3 for Windows (SAS Institute, Cary, NC, United States) and Statistica version 10 (Statsoft, Tulsa, OK, United States).

RESULTS

Demographic characteristics and clinical history of women enrolled in this study

Descriptive data for essential demographic characteristics and the clinical history of women enrolled in this study are summarized in Table 1. Young women averaged 25.2 ± 6.3 years (range: 14-50 years) and older women were 62.1 ± 8.6 years old (range: 51-89 years). The vast majority of young women came from urban areas (97.4% *vs* 2.6% from rural areas). Among older women, urban residence was also predominant (70.9% *vs* 29.1%). Transfusion history was more frequent in old women (7%) than in younger ones (2.1%), ($P < 0.01$), as well as hospitalization history (33.2% *vs* 13.8%), ($P < 0.01$). A minority of old women (15.3%) had an accurate knowledge of their HIV serological status, either positive or negative. This proportion was higher among young women (58.8%). By contrast, only 4.8% of old women and 1.6% of young women were aware of their HCV serological status. As for condom use, there was a low proportion of young women (21.9%) who claimed to use

Table 2 Risk factors according to both hepatitis C virus seropositivity and active infection in older women

Variables	Anti-HCV					HCV-RNA				
	Negative	Ind	Positive	OR (95%CI)	*P* value	Negative	Ind	Positive	OR (95%CI)	*P* value
Hospitalization										
No	146	4	3			151	0	2		
Yes	64	0	12	4.13 (1.60-10.97)	< 0.01	65	0	11	12.8 (2.75-59.30)	< 0.01
Transfusion										
No	196	4	14			202	0	12		
Yes	15	0	1	0.74 (0.09-5.83)	0.77	15	0	1	1.12 (0.14-9.22)	0.91

Ind: Indeterminate result of the INNO-LIA hepatitis C virus (HCV) confirmation test.

it quite often. Among them, 53.9% claimed to use it for contraception and 52.1% for the prevention of HIV and infections transmitted by sexual relation (HIV-ITS). Regarding marital status, 47% of older women were married, 50.4% were widowed and 2.6% were divorced. For young women, 91.9% were married, 7.7% were single, 0.2% were widowed and 0.2% were divorced.

Prevalence of HIV and HCV infections

HCV: Our study shows that HCV antibody prevalence was 0.2% (2/1000) among young women and that HCV-RNA prevalence in that subpopulation was 0.1% (1/1000). Among older women, prevalence was measured at 6.5% (15/231) for HCV antibodies and 5.6% (13/231) for viral HCV-RNA. HCV prevalence was significantly higher in old women compared to younger ones ($P < 0.01$). In both series HCV genotypes 1 and 2 were detected with a clear predominance of genotype 2 (84.6%). Interestingly, the INNO-LIA HCV confirmation test performed on positive MONOLISA HCV Ab/Ag samples allowed us to determine a rate of 42.9% and 9.5% of false positive results for young and older women respectively[6].

HIV: HIV screening of both young and old women allowed us to determine an HIV seroprevalence of 4.1% and 6.1% respectively in these subpopulations[6].

Knowledge of the HCV or HIV serological status among seropositive patients

HCV: Among HCV infected patients, respectively 93.3% (14/15) of older women and 100% (2/2) of young women were unaware of their serological status prior to the survey.

HIV: While 25% (10/40) of infected young women were unaware of their HIV status, 57.1% (8/14) of infected older women had no knowledge of their HIV status prior to the survey. Infected old women were significantly less informed about HIV than younger ones ($P < 0.05$).

Risk factors of HCV infection

Series of young women: Univariate analysis of the data collected in the young women cohort revealed a significant correlation between HCV infection and age: the median age for HCV seronegative women was 25 years while the median age for HCV seropositive women was 44.5 years OR = 1.6; 95%CI: 1.2-2.6; $P < 0.01$. Similarly, young rural women had a higher risk of HCV infection than those from urban areas (OR = 0.03; 95%CI: 0.002-0.43; $P < 0.05$). Of note, the very low prevalence of HCV infection among young women did not allow for a detailed analysis of variables in relation to HCV status.

Series of women > 50 years old: In older women, the univariate analysis (Table 2) showed a significant correlation between hospitalization history and both HCV seropositivity and active infection. Indeed, a significant proportion of older women infected with HCV (80% for antibodies and 84.6% for viraemia) had at least one hospitalization history.

In contrast to young women, HCV seropositivity in older women was not associated with age. Likewise, HCV seropositivity was not associated with urban or rural residence in older women (OR = 0.69; 95%CI: 0.26-1.84; $P > 0.05$). Furthermore, the logistic regression analysis of the HCV seropositivity according to both residence (rural or urban) and hospitalization history (yes or no), showed that the proportion of infected old women was 5 times higher in cases with hospitalization history (OR = 13.4; $P = 0.0002$), while the residence variable had no predictive value (OR = 2.7; $P = 0.13$).

Interestingly, our study did not show a correlation between HCV infection and blood transfusion in older women.

Comparison of HCV infectious risk in young and old women

Univariate analysis showed that prevalence of HCV infection was higher in older women compared to young ones. Furthermore, these older women were more exposed than younger ones to risk factors of HCV infection such as dental care (OR = 45; 95%CI: 10-193), fibroscopy (OR = 38; 95%CI: 8.7-166) and tattooing (OR = 37; 95%CI: 8.5-165), and these differences were highly significant ($P < 0.01$). As explained above, prevalence of HCV infection in young women was higher in rural areas while there was no difference for HCV seropositivity in older women with regard to rural or urban residence. Overall, the proportion of HCV seropositive women was significantly higher in rural areas (7%) than in urban areas (1%), ($P < 0.01$).

Table 3 Human immunodeficiency virus status - multivariate logistic model

Variables	Estimation	SE	OR	*P* value
Marital status (monogamous)	0.29	0.16	1.35	0.06
Travel (husband/partner)	0.55	0.17	1.73	0.002
Condom use (HIV or ITS prevention)	- 0.78	0.18	0.46	< 0.01
HIV knowledge (sexual routes)	- 0.43	0.26	0.65	0.09

HIV: Human immunodeficiency virus; ITS: Infections transmitted by sexual relation.

Risk factors for HIV infection

Series of young women: The median age of HIV seronegative women was 25 years, which was similar to the median age of 26 years observed in the seropositive cohort.

Univariate analysis showed an association between HIV infection and 9 explicative variables such as locality (higher prevalence of women from Municipality Ⅱ, $P = 0.03$); monogamy (low frequency of infection, $P = 0.075$); knowledge of sexual transmission (higher frequency of infection, $P < 0.01$); absence of knowledge on transmission modes (low frequency of infection, $P = 0.052$); condom use (very low frequency of infection, $P < 0.01$); condom use for ITS/HIV prevention (higher frequency of infection, $P < 0.01$); superior instruction level (very low frequency of infection, $P < 0.01$); travel of husband/partner (very low frequency of infection, $P < 0.01$); knowledge of the infectious status (high frequency of infection, $P = 0.059$).

Two additional variables (infibulation and anorexia/skin rash) were included because HIV seroprevalence was twice higher among subjects who reported infibulation history or presented such symptoms.

Multivariate analysis of these 11 variables (Table 3) showed (with inclusion $P = 0.05$ and exclusion $P = 0.10$): (1) a decrease of the HIV infection risk among monogamous married women; (2) a decrease of the HIV infection risk among women whose husbands or partners travel; (3) an increase of the HIV infection risk among women who used condoms for infectious diseases prevention; and (4) an increase of the risk of HIV infection among women who knew that acquired immunodeficiency syndrome is transmitted by sexual routes.

Series of women > 50 years old: The median age for HIV seronegative women was 60 years while the median age for HIV seropositive women was 52 years, but the difference was not significant. The HIV seroprevalence did not change significantly with either age or locality of sample collection. Likewise, HIV infection was not associated with the type of residence. Married and widowed older women were significantly less affected by HIV infection than divorced ones ($P < 0.05$).

Comparison of HIV infectious risk in young and old women: Univariate analysis showed that young women, who knew that HIV is spread through sexual relation (OR = 2.6; 95%CI: 1.3-5.3; $P < 0.01$), blood (OR = 2.5; 95%CI: 1.2-5.2; $P < 0.05$) or from mother to child (OR = 2; 95%CI: 1.0-3.95; $P < 0.05$), were more frequently infected with HIV than older women who knew these modes of transmission, respectively. Regarding subjects whose travel time exceeded 6 mo, old women were more frequently infected with HIV than the younger ones (11% *vs* 2%), (OR = 2.9; 95%CI: 1.04-7.9; $P < 0.05$).

In contrast to what has been described for HCV, the proportion of HIV infected women was not associated to rural or urban residence (6/92 *vs* 48/1120) ($P > 0.05$).

Comparison of risk factors in the two subpopulations: Univariate analysis (Table 4) showed that HIV seropositivity of young women was associated with variables such as locality of sample collection, knowledge of sexual route and dialysis, unlike old women.

We have noted that among young women with HIV infection, 39% came from municipality number Ⅱ (OR = 3.79; 95%CI: 1.2-11.6; $P < 0.05$). Surprisingly, it was observed that HIV prevalence was higher in young women who knew that HIV is transmitted by sexual relation, compared to those who were less informed (OR = 7.5; 95%CI: 1-55; $P < 0.05$). Young women who had undergone dialysis were also at greater risk of HIV infection (OR = 24; 95%CI: 1.5-387; $P < 0.05$). Out of two women who had undergone dialysis, one was HIV-positive and was aware of her status. As expected, young women who used condoms were significantly less infected than those who did not use it (OR = 3.6; 95%CI: 2-7; $P < 0.01$). Moreover, young women who used condoms as a contraceptive method were significantly less infected (OR = 0.14; 95%CI: 0.04-0.48; $P < 0.01$) than those who claimed to use it for other purposes. On the other hand, those who used it to prevent HIV-ITS were significantly more infected than those who claimed not to use it for this reason (OR = 5.5; 95%CI: 1.5-19; $P < 0.01$). Young women who reported that their partner was traveling quite often were paradoxically significantly less affected by HIV infection than those whose partner did not travel frequently (1.93% *vs* 6.22%) (OR = 0.3; 95%CI: 0.14-0.63; $P < 0.01$).

In older women, divorced subjects were significantly more affected by HIV infection than married and widowed ones (OR = 0.01; 95%CI: 0.01-0.78; $P < 0.05$).

Tattooing, scarification and/or piercing were not significantly associated with HIV infection. Likewise, the variables such as transfusion, hospitalization, dental care, excision and residence (rural or urban), were not associated with HIV infection.

DISCUSSION

The aim of our study was to carry out a comparative epidemiological analysis of risk factors for HIV and HCV infections in order to develop prevention means in Mali for these diseases. This study is the first to make a comparative epidemiological analysis of risk factors linked to HIV and HCV in Mali.

In this regard, two cohorts of patients (young women and women over 50 years) were recruited in two consecutive periods over two years in the same geographical

Table 4 Comparison of risk factors for human immunodeficiency virus infection among young and older women

Variables	Anti-HIV									
	Young women (≤ 50 yr)					Older women (> 50 yr)				
	Negative	%	Positive	%	*P* value	Negative	%	Positive	%	*P* value
Locality										
Municipality Ⅱ (CSRef)/CHU-GT (hospital)	150	15.7	16	39		149	69.6	9	64.3	
Other municipalities/CH-ME	803	84.3	25	61	0.020	65	30.4	5	35.7	0.680
Marital status										
Single	71	7.5	5	12.2						
Divorced	2	0.2	0	0		4	1.9	2	14	
Married	877	92.2	35	85.4		101	47.4	6	43	0.027
Widowed	1	0.1	1	2.4	0.070	108	50.7	6	43	0.022
Knowledge of sexual routes										
No	147	16.1	1	2.5		106	63.1	9	64.3	
Yes	766	83.9	39	97.5	0.047	62	36.9	5	35.7	0.930
Condom use										
No	751	79.2	20	51.3				N/I		
Yes	197	20.8	19	48.7	< 0.01					
Condom use to prevent HIV/ITS										
No	100	50.8	3	15.8				N/I		
Yes	97	49.2	16	84.2	0.008					
Condom use for contraception										
No	83	42.1	16	84.2				N/I		
Yes	114	57.9	3	15.8	0.002					
Travel of husband/partner										
No	482	51.4	32	78.1				N/I		
Yes	456	48.6	9	21.9	0.002					
Knowledge of the infectious status (from questionary)										
No	392	41.9	10	25		184	86.4	8	57.1	
Yes	544	58.1	30	75	0.038	29	13.6	6	42.9	0.007
Dialysis										
No	950	99.9	40	97.6		211	99.5	14	100	
Yes	1	0.1	1	2.4	0.026	1	0.5	0	0	0.990
Tattooing/scarification/piercing										
No	291	30.9	14	35.9		112	54.1	4	28.6	
Yes	652	69.1	25	64.1	0.510	95	45.9	10	71.4	0.075
Transfusion										
No	925	97.9	39	97.5		197	92.5	14	100	
Yes	20	2.1	1	2.5	0.870	16	7.5	0	0	0.980
Hospitalization										
No	816	86.1	37	90.2		141	66.5	10	71.4	
Yes	132	13.9	4	9.8	0.450	71	33.5	4	28.6	0.710
Dental care										
No	574	60.9	21	52.5		128	60.7	8	57.1	
Yes	369	39.1	19	47.5	0.290	83	39.3	6	42.9	0.790
Excision										
No	92	9.7	4	9.8				N/I		
Yes	859	90.3	37	90.2	0.970					
Residence area										
Rural	25	2.7	1	2.4		61	28.5	5	38.5	
Urban	919	97.3	40	97.6	0.930	153	71.5	8	61.5	0.450

N/I: Not implemented in old women (cultural context); CSRef: Reference health center; CHU-GT: Hospital university Gabriel TOURE; CH-ME: Mother-Child hospital; HIV: Human immunodeficiency virus.

region. Of note, the target population was essentially urban, but the proportion of old women coming from rural areas was higher than that of younger ones (29.1% *vs* 2.6%) ($P < 0.01$). The seroprevalence of HCV among young women was very low (0.2%). By contrast it was significantly much higher in women > 50 years (6.5%), ($P < 0.01$). This trend with age was also observed for the HCV viraemia (5.6% *vs* 0.1%). Overall, the seroprevalence of the Malian women population is estimated at 1.3%. Interestingly, Diarra *et al*[3] reported a seroprevalence of 3.3% for HCV infection in Malian blood donors.

In this study, we show that the proportion of HCV seropositive women in Mali is significantly higher in rural areas (7%) than in urban regions (1%), suggesting that the rural residence area is a risk factor in Mali for HCV infection. This is confirmed in the young women subpopulation although the HCV seroprevalence was low in this group and those women came mostly from urban areas. By contrast, the seroprevalence reached a higher level for older women, but we could not see any association between HCV infection and the residence area

for this category. This discrepancy can be explained by a second risk factor, the hospitalization history. Indeed, we observed that the proportion of hospitalized women is higher in older women than in young ones (33.2% *vs* 13.9%). Furthermore, the logistic regression analysis combining residence and hospitalization risk factors showed that the proportion of infected old women is approximately 5 times higher in previously hospitalized subjects (OR = 13.4; $P = 0.0002$), while residence was not significantly associated with HCV infection (OR = 2.7; $P = 0.13$). This suggests that hygienic precautions in health care may not be well respected in rural areas.

We observed increased HCV prevalence with respect to age, similarly to other reports[8-10]. There was no association between HCV seroprevalence (or viraemia) and gravidity or parity among young women. Older women are more exposed than young women to risk factors for HCV infection such as dental care, endoscopy (fibroscopy) and percutaneous procedures (tattooing), and these differences are highly significant (OR > 1; $P < 0.01$). As usually described in the literature, the origin of HCV infection is unknown in about 20% of cases. A very careful and thorough investigation can sometimes reveal a past episode of drug addiction or a previous medical procedure possibly associated with transfusion[2]. Nosocomial risk by itself is difficult to assess[11]. History of surgery or medical invasive procedures does not necessarily mean that HCV infection is nosocomial. Indeed, transfusion of blood products during surgery or reanimation may be ignored by the patients[11]. Outside transfusion and organ transplants, nosocomial infection is essentially due to the use of poorly sterilized materials[11-20]. Estimations of HCV transmission through unsafe injections in developing countries indicate that 2.3 to 4.7 million infections should occur annually because of such practices[2]. Some rare cases of doctor-to-patient transmission have also been reported during cardiothoracic and gynecologic surgery[21,22]. In addition, an important cultural practice, excision, performed usually on several women at once in non-sterile conditions, is common in Malian rural areas. Moreover, the excision has been reported as a risk factor for HCV transmission in Burkina Faso, a neighboring country of Mali[23]. We note that approximately 90% of young women recruited in our study reported to have been excised. Only 2 of them were HCV seropositive. Excision as a risk factor was not studied in older women because excision is a cultural taboo of Mali, despite awareness campaigns and, paradoxically, the high frequency of this practice.

Our study did not show any significant association between HCV infection and transfusion history among older women whose HCV seroprevalence is high. Similar observations were also reported by Maiga Moussa *et al*[4] who did not observe a single case of transfusion history in their cohort. Indeed, in our study only one of the oldest women transfused was HCV seropositive (6.25%), while no transfused younger women was HCV seropositive. Blood transfusion has been cited as the most important risk factor of HCV infection among pregnant women in Burkina Faso[23]. Our study seems to indicate instead that nosocomial transmission is the highest risk factor of HCV infection in Mali. Of note, the proportion of transfused subjects is low in the two subpopulations, 2% and 7% for young and older women respectively. Therefore, our present results should be confirmed on a larger cohort of transfused patients.

Drug addiction is the major mode for transmission of HCV infection in industrialized countries[2]. This parameter is not investigated by our study. Of note Maiga Moussa *et al*[4] reported the absence of drug addiction history in their series.

Previous studies have highlighted a relationship between HCV seroprevalence and dialysis, independently of the use of blood products[24-27]. However, our study shows no association between HCV seropositivity and dialysis. Again, our study included very small numbers of dialyzed subjects, respectively 0.2% in young women and 0.4% in older ones, thus precluding any definitive conclusions. Baby *et al*[5] have reported an HCV seroprevalence of 19.7% (13/66) in chronic hemodialysis patients admitted to the nephrology department of the Hospital Point G in Bamako.

In our study conducted among old women (over 50 years), we evaluated the prevalence of HCV infection at a lower rate than that reported in previous studies undertaken among chronic hepatitis patients (25.3%) or hemodialysed patients (19.7%). In addition, serological screening assays were not confirmed by Western blot or PCR analysis in these studies. Indeed, the rate of false positive results of the screening assay (MONOLISA HCV Ab/Ag Ultra) is close to 10% in the old women subpopulation[6]. The poor performance of HCV immuno-assays due to false positive reactions in African samples was also reported in other studies[28-32].

Our study has evaluated the HIV seroprevalence rate at 4.1% and 6.1% respectively in young and older women which is higher than 1.3% reported in the Malian general population[33]. As expected, we observed the importance of condom use as a factor that decreases the risk of HIV transmission, in accordance with EDSM report (EDSM-Ⅳ 2006, final report 2007)[33]. We have demonstrated that HIV rate is higher in young women who knew that HIV is propagated by sexual relation compared to those who did not know it. We have also shown that HIV frequency is higher in young women who use condoms to prevent infection than those who use it for another reason. This is confirmed by the fact that HIV infection was significantly less prominent in young women who used condoms more as a means of contraception than for another reason. This raises the question whether recommendations related to prevention such as information, education and communication (IEC) are well understood, correctly followed by the public, and diffused efficiently in the Malian population. The study shows that the young women who have a superior instruction level were significantly less infected

with HIV, which stresses the critical importance of public information in limiting HIV propagation.

Young women, who reported that their partner was traveling quite often, were less affected by HIV infection compared to those whose partners did not travel frequently. This is quite paradoxical and unexpected. A high rate of HIV infections was observed in the municipality number Ⅱ among young women. Indeed, in 2007, a support program for seropositive women was initiated in this health center, which resulted in increased attendance by these patients.

HIV infection rate was higher in divorced women compared to married women and widows. Several hypotheses may explain this observation: women may have divorced because of the unfaithfulness of their partner or divorced women may have several sexual partners. Our observation is confirmed by EDSM report (EDSM-Ⅳ 2006, final report 2007), that has showed that divorce is a risk factor for transmission of HIV infection[33]. According to this study, the level of HIV seroprevalence increases with the number of sexual partners: from 1.1% in women who had only one sexual partner, the prevalence increases to 3.3% among women who had 3 or 4 partners. Likewise, Kirere Mathe *et al*[34] reported that divorce is a risk factor of HIV infection.

Our study showed no significant association between HIV infection and the excision or infibulation in young women. We did not observe any association between percutaneous procedures (tattooing, scarification or piercing) and HIV or HCV infection among women. However, these practices are not trivial and can be considered as risk factors for the transmission of viral infection if health and safety measures are not followed. Although our study focuses on women living mainly in urban areas (*i.e.*, 97.37% for young women and 70.87% for older women), the overall proportion of women living with HIV, unlike HCV, does not change significantly according to the type of residence.

Interestingly the present study did not show any HIV and HCV coinfection. Of note a rare HIV/HCV coinfection has been reported in the general population in southern Cameroon where both infections are endemic[35].

In conclusion, our study reveals that HCV propagation is achieved mainly through medical procedures with contaminated supplies rather than through blood transfusion while HIV transmission may be predominantly of sexual origin in Mali. Our data confirms that condom use significantly reduces the risk of HIV transmission. Furthermore, we have observed that HIV seropositive patients who are aware of their serological status are informed about the risk of transmission. This study supports the idea that efforts should be made to promote the early screening, to reinforce prevention campaigns (IEC) and that targeted strategies should be developed in order to strongly sensitize people with low instruction level as well as the general Malian population to the risk of sexual transmission of HIV. Among HCV infected patients, respectively 93.3% of older women and 100% of young women were unaware of their serological status. Similarly, an estimated 45% to 85% of United States adults are chronically infected with HCV, yet unaware of their condition[36]. Efforts must be focused on screening and treatment in general, and specifically on reinforcing hygienic measures in medical centers, and mainly in rural areas, in order to reduce the risk of nosocomial transmission of HCV.

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COMMENTS

Background

Human immunodeficiency virus (HIV) infection is propagated mainly through blood transfusion (before 1985), intravenous drug use, professional exposure in medical personnel, sexual transmission and mother-to-child transmission. Hepatitis C virus (HCV) contamination is also caused by intravenous drug use and blood transfusion (before 1991), while vertical transmission accounts for less than 5% of the cases and sexual transmission is exceptional. In Mali, HCV studies have been mostly conducted among specific populations such as blood donors, patients suffering from chronic hepatitis or hemodialysis patients. Studies on the extent and epidemiology of HCV infection in the general Malian population are not abundant. The present study aims to document epidemiologic patterns, risk factors and modes of transmission shared by both diseases in Mali.

Research frontiers

Similarly to this study, other authors reported age as risk factor of HCV infection. In this study conducted among old women (over 50 years), the authors evaluated the prevalence of HCV infection at a rate of 3-4 times lower than those described in two other studies undertaken in Mali. These differences may be explained by the fact that previous studies were conducted on patients with chronic hepatitis or hemodialysed patients. In addition, serological screening assays were not confirmed by Western blot or polymerase chain reaction analysis in these studies. Indeed, the rate of false positive results of the screening assay (MONOLISA HCV Ab/Ag Ultra) is close to 10% in the old women subpopulation, as shown here. Moreover, the excision has been reported as a risk factor for HCV transmission in Burkina Faso, a neighboring country of Mali. The authors note that approximately 90% of young women recruited in this study reported to have been excised. Out of them, only 2 were HCV seropositive. Blood transfusion has been cited as the most important risk factor of HCV infection among pregnant women in Burkina Faso. This study seems to indicate instead that nosocomial transmission is the highest risk factor of HCV infection in Mali. Concerning HIV, the authors have estimated seroprevalence at 4.1% and 6.1% respectively in young and older women, which is higher than 1.3% reported previously in the Malian general population.

Innovations and breakthroughs

This study presents for the first time in Mali a comparative epidemiological analysis of risk factors for HIV and HCV infections and the molecular epidemiological profile of HCV. The observed genotypes are HCV-1 and HCV-2 (with predominance of genotype 2). This data is also evidence of epidemiological disparities for HIV and HCV transmission in Mali (HIV essentially sexual and HCV mainly nosocomial).

Applications

The study supports the idea that efforts should be made to reinforce prevention campaigns and that targeted strategies should be developed in order to strongly sensitize people with low instruction level as well as the general Malian popula-

tion to the risk of sexual transmission of HIV. Among HCV infected patients, respectively 93.3% of older women and 100% of young women were unaware of their serological status. Similarly, an estimated 45% to 85% of United States adults are chronically infected with HCV, yet unaware of their condition. Efforts must be focused on screening and treatment in general, and specifically on reinforcing hygienic measures in medical centers, and mainly in rural areas, in order to reduce the risk of nosocomial transmission of hepatitis C virus.

Peer review

This is an interesting manuscript.

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