Risk factors for viral hepatitis C infection in Rwanda: Results from a Nationwide Screening Program

Jean Damascene Makuza (makorofr@gmail.com)
Rwanda Biomedical Center https://orcid.org/0000-0001-9275-8844

Carol Y Liu
Clincton Health Access Initiative

Corneille Killy Ntihabose
Rwanda Biomedical Center

Donatha Dushimiyimana
Rwanda Biomedical Center

Sabine Umuraza
Clincton Health Initiative

Marie Paul Nisingizwe
University of British Columbia

Justine Umutesi
Rwanda Biomedical Center

Janvier Serumondo
Rwanda Biomedical Center

Soline Dusabeyesu Mugeni
Clincton Health Initiative

Muhamed Semakula
Rwanda Biomedical Center

Neil Gupta
Brigham and Women's Hospital

Margaret Hellard
Monash University

Sabin Nsanzimana
Rwanda Biomedical Center

Research article

Keywords: Viral Hepatitis C, risk factors, Rwanda

Posted Date: May 29th, 2019

DOI: https://doi.org/10.21203/rs.2.9671/v1

Version of Record: A version of this preprint was published on August 5th, 2019. See the published version at https://doi.org/10.1186/s12879-019-4322-7.

Abstract

Background The epidemiology and risk factors for hepatitis C virus (HCV) infection in Rwanda are not well known; however, this information is crucial to shaping the country's public health approach to hepatitis C control. Methods A HCV screening campaign was conducted in the general population in 24 districts previously identified to have a high HCV disease burden at the time of sample collection, sociodemographic information and self-reported risk factors were collected. Bivariate and multivariate logistic regressions were conducted to assess risk factors independently associated with HCVAb seroprevalence. Results Out of a total of 326,263 individuals screened for HCVAb, 22183 (6.8%) were positive. In multivariate analysis, risk factors identified as statistically associated with HCVAb positivity include history of traditional operation or scarification (OR=1.091, 95% CI: 1.049-1.135), presence of viral hepatitis in the family (OR=1.268, 95% CI: 1.151-1.397), widowed or separated/divorced (OR=1.36, 95% CI: 1.257-1.471), South province (OR=1.978, 95% CI: 1.884-2.077) and age 65 years old and over (OR=4.857, 95% CI: 4.617-5.110). Ubudehe category 3 (OR=0.966, 95% CI: 0.927-1.008) and participants using RAMA insurance (OR=0.775, 95% CI: 0.704-0.854) had lower odds of HCV seropositivity. Conclusions Our findings provide important information for Rwanda's strategy on prevention and case-finding. Future prevention interventions will aim to reduce transmission through targeted messaging around traditional healing practices and future case-finding will target individuals with a history of exposure or of older age.

Introduction

Globally, an estimated 71 million people are infected with chronic hepatitis C virus (HCV) infection[1]. Viral hepatitis contributed to 1.34 million deaths in 2015, a number comparable to annual deaths caused by tuberculosis and exceeding annual deaths caused by HIV. HCV accounts for around 400,000 deaths per year[2] and HCV-associated deaths in 2015 were mainly caused by chronic liver disease such as decompensated cirrhosis and liver cancer. The overall global HCV prevalence is estimated to be 2.5% and around 2.9% in Africa[3].

While HCV is increasingly highlighted as an important contributor to disease burden in high-income countries such as Europe, Canada and the United States[4], the burden in African regions is less known and thought to be highly variable across geographic area [5]. The prevalence of HCV among the general population in Sub-Saharan African (SSA) ranges from 0.1% to 17.5%, with countries such as Burundi (11.3%) and Cameroon (13.8%) among some of the countries with the highest prevalence in the world[6]. While increasing resources have been dedicated to address the burden of HCV in some high-income countries, to date, there remains a lack of strategic planning for prevention and management of HCV in SSA despite accumulating evidence of a significant disease burden[5]. The lack of a coordinated response among countries in SSA has further led to uncertainties on HCV prevalence and its variations across sociodemographic and geographic factors. Moreover, few studies in SSA have quantified the prevalence of past-exposures to known risk factors. The association between such risk factors and HCV infection and those studies were conducted only on specific groups, such as people living with HIV and MSM[7,8] rather than the general population.

In Rwanda, the prevalence of HCV is not well known among the general population. Recent studies conducted in specific population groups have found the prevalence of anti-HCV (HCVAb), a marker for exposure to HCV, to be between 4.3-4.7% among people living with HIV and 2.6% among pregnant women [9,10]. Among these studies none have assessed risk factors for HCV in Rwanda.

In addition to uncertainties around HCVAb prevalence, risk factors for HCV infection in Rwanda have not been quantified on a national scale. Globally, older age, occupational and recreational exposure to blood products by healthcare workers or individuals exposed to body piercings were shown to be risk factors for HCV [16–19]. In Africa, a systematic review yielded a wide range of high risk populations including, individuals infected with HIV, patients on hemodialysis, patients with history of blood transfusions, health care workers after needle stick injuries and sexually active adults with multiple partners [6].

Rwanda recently announced an ambitious campaign to eliminate HCV. Understanding the HCV prevalence and current drivers of transmission will be crucial to guiding more efficient screening campaigns and implementing preventative activities to reduce population exposure to major routes of transmission. This study reports on the results from an HCV testing campaign conducted by the Government of Rwanda including the risk factors most likely contributing to the HCV disease burden in Rwanda.

Methods

Study design: The study consists of a secondary analysis of cross-sectional data collected during the 2018 screening campaign. All data used for analysis was collected at the time of viral hepatitis screening through use of a standardized laboratory request form.

Study population and recruitment of participants: In response to the global and regional urgency to address HCV and improve understanding around HCV epidemiology, the Rwanda Biomedical Center (RBC) and partners prepared screening campaigns to identify infected patients to be linked to treatment free-of-charge to the patient. In 2018, campaigns were specifically conducted in districts previously found to have high prevalence of HCV among the general population and targeted individuals aged 25 years old and above from all districts in Southern, Eastern and Northern provinces The study population consists of voluntary participants of the 2018 campaigns. People with confirmed chronic HCV who are on treatment or in pre-treatment and patients previously treated with direct acting antivirals (DAAs) were excluded. Screening campaigns were conducted between March to October 2018 for two weeks in each district. Community awareness for viral hepatitis screening was done by radio advertisements and with the help of community health workers before and during the screening period. Individuals who belonged to targeted demographic groups and attended screening sites (health centers) were screened for HCV and included in the study population of this analysis.

Data collection procedures: Samples were collected after verbal consent by trained nurses and laboratory technicians who used a lab request form to record demographic, clinical, and behavior characteristics. Unlike previous campaigns, the 2018 campaign asked individuals about their exposure to a list of known risk factors for HCV including history of undergoing health treatments such as blood transfusions, surgical interventions and traditional operations or scarifications and comorbidities such as TB, diabetes and cancer. Testing was performed at 13 sites across Rwanda using Murex enzyme-linked immunosorbent assays (ELISA) for HCVAb (version 4.0; DiaSorin S.p.A, Italy). All testing was supervised by a team of laboratory technicians from the National Reference Laboratory. When laboratory results were available, the results and the contents of the lab request form were entered into an encrypted database (Microsoft Excel). The database was de-identified for the present study and no persons involved in the analysis of data were able to access the linked database.

Variables: The primary outcome of interest was HCVAb seroprevalence; it was a binary variable of either positive or negative as determined by the ELISA test. Independent variables included: age, sex, screening district, marital status and socioeconomic status (Ubudehe category). Ubudehe is a development programme whereby citizens are placed into different categories. The lowest socioeconomic category is 1 and the highest is 4. Socioeconomic status was defined in accordance with the updated Ubudehe category by the Ministry of Local government of Rwanda (MINALOC)[17]. HIV status as well as comorbidities and exposures to HCV risk factors were self-reported. Comorbidities assessed included high blood pressure (HBP), diabetes, chronic renal failure (CRF), cancer, tuberculosis (TB). Risk factors assessed that were associated with parenteral transmission routes included history of health facility-based surgical operation, traditional surgical operation and transfusion. Traditional surgical operation practices are defined as scarifications, tattoos, traditional dental extraction or uvulectomy done by a community member or traditional practitioner. Other risk factors assessed were multiple sexual partners and self-reported presence of diagnosed viral hepatitis in a family member.

Statistical methods & data analysis: Individuals who participated in screening were line-listed. After data cleaning, data was transferred and analyzed using SPSS version 20.0. Pearson Chi-square tests were used to test for association between HCVAb seroprevalence and other categorical or binary variables. Potential determinants of HCV infection were assessed in

bivariate and multivariable models using logistic regressions with HCVAb seroprevalence as the outcome variable. Multivariate analysis was used to determine socio-demographic, behavioral and clinical factors that were independently associated with HCVAb positivity. Age was categorized into five groups: less than 35 years old, 35-44 years old, 45-54 years old, 55-64 years old and over 65 years old. For health insurance, only community-based health insurance (Mutuelle), la Rwandaise Assurance Maladie (RAMA), and Medical Military Insurance (MMI) were categorized separately; all other insurances were categorized as “private insurances”. Marital status was categorized into three groups of married, single and widowed, separated or divorced.

All variables in bivariate analyses were considered for inclusion in multivariate regression model if their inclusion was conceptually logical. Variables that were not significant were eliminated using backward stepwise method, producing a final model that could determine independent association between variables and HCV infection. In the final multivariate model, variables with p-values less than or equal to 0.05 in multivariate analysis were considered statistically associated with HCV seroprevalence.

Ethics: The routinely collected program data analyzed for this study is maintained by the Rwanda Biomedical Center Division of HIV/AIDS, STIs and Other Blood Borne Infections. The ethical procedures for the collection of these data were governed by the Medical Research Council of Rwanda and site authorizations were obtained from the Ministry of Health for hosting sites. The approval (No 2407/RBC/2019) for utilization of data was obtained by Rwanda Biomedical Center.

Results

Study population: The total number of individuals screened was 327383; 326263(99.7%) had available results of which 22183 (6.8%) screened positive for HCVAb. People who did not have results: 1120(0.3%) were those who refused blood sampling due to fear, people who their taken samples were insufficient for testing and some tests which failed during testing. Socio-demographic characteristics of the study population are shown in Table 1. The mean age of participants was 44.8 years. There were 145,537 (45.8%) individuals older than 45 years of age, 224382 (68.8%) were female, 247437 (77.5%) were married. 149092 (45.5%) were in Ubudehe category 3 and 234 (0.1%) were in Ubudehe category 4. The vast majority of particpants 303206 (93.6%) were using community-based health insurance (mutuelle). The province with the highest number of individuals screened was Eastern Province where 110337 (35.0%) of participants were screened.

Table 2 shows self-reported clinical characteristics and historical exposures of participants. Among comorbidities, 1867 (0.6%) reported diabetes, 9510 (2.9%) reported high blood pressure (HBP), 578(0.2%) reported chronic renal failure (CRF), 293 (0.2%) reported cancer, 6597 (2%) HIV positive and 338 (0.1%) reported a history of tuberculosis. Among self-reported historical exposures to risk factors, 17876 (5.6%) were surgically operated at least once, 5350 (1.6%) received a blood transfusion at least once, 54097 (16.6%) had history of a traditional surgical practice, 8755 (2.7%) had multiple sex partners, either current or historical, and 6190 (1.9%) had a family member diagnosed with viral hepatitis. Among all variables, no variables had >5% missing values.

In the multivariate analysis as shown in table 3, sociodemographic factors statistically associated with HCVAb positivity included male sex adjusted-OR (aOR)=1.063, p-value<0.001], age group 55-64 years old (aOR=2.105, p <0.001), age group 65years old and above (aOR=4.865, p <0.001), being widowed, separated and divorced (aOR=1.360, p <0.001). Being in Ubudehe category 3 had lower RAMA as health insurance had lower odds of HCVAb seroprevalence compared to those on mutuelle (aOR=0.775, p <0.001.) being in Ubudehe category 3 had lower odds of HCVAB seroprevalence than being in Ubudehe category 1 (aOR=0.919 p <0.001.). Comparing Northern Province with remaining provinces, they were shown to be associated with HCV Ab positivity: for West (aOR=1.192, p<0.001) for South (aOR=1.978, p<0.001), for East (aOR=1.369, p<0.001) . Self-reported co-morbidities found to be associated with HCVAb prevalence in the multivariate analysis included high blood pressure (aOR=1.217 p<0.001) and CRF (aOR=1.291, p <0.001). Self-reported risk factors associated with HCVAb prevalence were history of traditional surgical practices (aOR=1.091, p <0.001) and history of a family member diagnosed with viral hepatitis (aOR=1.268, p-value<0.001).

Discussion

This study is the first national-level study in Rwanda to assess risk factors for HCV using the country's seroprevalence survey for HCV exposure (HCVAb). The national-level coverage and large sample size contribute to the strength of our findings. To our knowledge this is the first study to assess risk factors associated with HCVAb prevalence in a nationally-representative screening program for members of the general population in SSA.

Compared to previous studies conducted in Rwanda among PLHIV and pregnant women that produced prevalence estimates of 4.6% and 2.6% respectively[9,10], the HCVAb seroprevalence estimated by this study is 6.8%. The likely explanation for this higher prevalence is the strategic decision by the campaign to target older individuals and the self-selected nature of voluntary participants where individuals who had reason to suspect they had viral hepatitis may have come forward for testing. Factors associated with being HCVAb positive following adjusted analysis included older age, lower socioeconomic status, geographic variation, family history of HCV and exposures to traditional surgical operations. Associations between HCV infection and both family history of HCV and exposures to traditional surgical operations remained significant after adjusting for age.

Traditional scarifications and operations, though heavily discouraged, are still widely prevalent in informal healthcare practices in Rwanda. Although data on frequency of traditional surgical practices in Rwanda is limited, the Rwanda Demographic Health Survey 2015 reported that 8.5% of circumcisions for people between 15-59 years old were performed by traditional practitioners or a family friend [18]. Collectively, these findings suggest a need for interventions targeted to traditional healers such as increasing population awareness on the risks of traditional cuttings for infectious disease transmission. The Ministry of Health and RBC strongly advise individuals in Rwanda to seek health advise from official health facilities rather than traditional healers. Our findings add further evidence to the potential harm of unregulated traditional practices.

Although the most frequently discussed transmission routes for HCV are parenteral, there has also been much debate on the impact of household exposure on HCV transmission[19]. Our study found an association between familial history of viral hepatitis and HCVAb prevalence. Previous observational studies have reported clustering of cases within households and documented evidence of higher disease prevalence among individuals with an infected family member compared to the general population[20–23]. Moreover, a recent cross-sectional survey of HCV patients conducted in China showed that long term exposure to an infected family member was associated with infection[24], an indication that a constant exposure to low-risk transmission routes such as razors, tooth brushes and nail clippers could still contribute to infection. However, another plausible explanation for our findings is that members of the same household could be exposed to the same external risk factors. For example, family members visiting the same traditional medicine practitioner with unsafe needle practices will all have an elevated risk for infection. Given low awareness among the population on potential risk of intrafamilial transmission of HCV, patients with HCV should be counselled on prevention of disease transmission to their cohabitants. Cohabitants should be offered the option of receiving HCV counseling and undergoing HCV testing.

Similar to other studies conducted in Rwanda on people living with HIV and on pregnant women[9,10], older age showed strong associations with HCVAb with a trend of higher odds of infection with increasing age group (Figure 1). A hypothesis for this finding is that older individuals are more likely to have historical exposure to risk factors such as unhygienic medical procedures and scarifications, either within a health facility or with traditional practitioners, prior to implementation of current infection control policies.

Co-morbidities that showed associations with HCVAb prevalence were chronic renal failure and high blood pressure. These associations could be mediated by age, as most of the patients suffering from these diseases are aged though these associations were found to be independent in the multivariate model used in this study. According to the survey done by WHO in Rwanda (STEPS) 33.2% of people aged 55-64 years old had high blood pressure while 6.7% of people between 25-

34 years old had high blood pressure[25]. CRF could be a complication of chronic HCV and HCV can be acquired during different procedures performed by health care providers during management of CRF, such as dialysis [26]. Self-reported HIV infection was associated with HCVAb prevalence and can be explained by potential shared modes of transmission between HIV and HCV.

Individuals in socioeconomic category of Ubudehe category 3 have lower odds of HCVAb compared to individuals in the lowest socioeconomic category of Ubuduhe category 1. Individuals using RAMA as health insurance compared to those using mutuelle also have lower odds of infection. Individuals from lower socioeconomic categories may be at a higher risk for HCV due to more exposures to unhygienic practices in informal health settings or sharing of sharps such as razors.

This study also found that people from the Northern province have lower positivity for HCV compared to other provinces. This can be explained by the fact that other provinces have higher migration across borders and possibly more refugee camps. Apart from the socio-economic status which should be associated with HCV positivity, other unmeasured cultural practices or risk factors could have contributed to these geographical differences[10,11,13,14,24].

Several limitations were identified. The sample population consisted of voluntary participants who are likely to differ in risk profile compared to the Rwandan population at large. Thus, the prevalence estimate and risk factors found to be associated with HCVAb may not be generalizable to the entire population. As this study utilized presence of anti-HCV antibody as the primary marker of HCV infection, the risk factors identified are relevant for present or previous HCV infection and may not be associated with chronic viremic state. Other unmeasured risk factors such as exposure to mass casualties through war and conflict, sexual violence, refugee status, or community based traditional practices may have been more prevalent historically. Association between age and HCVAb positivity may be confounded by exposures to health treatment-related risk factors that were not assessed in this study. Lastly, this study relied on routinely collected data and self-report to assess clinical variables (e.g. HIV status) or historical exposure which may have led to misclassification. Participants are likely to have underreported at random with respect to the outcome due to poor recall of historical events, if a true association exists between HCV infection and variables identified in this study, then random misclassification of exposures would have led to dilution of odds ratios. If exposures were recorded accurately, we would expect the magnitude of ORs to increase. Also plausible is that individuals with lower health literacy had lower awareness of risk factors. These individuals could have had either higher risk for HCV infection- due to more exposures to less hygienic health practices-, or lower risk for HCV-due to less healthcare-seeking overall.

In conclusion, HCV is a worldwide epidemic that can cause death and severe liver disease complications especially in low- and middle-income countries and has been identified as a public health problem in Sub-Saharan Africa. The high HCVAb seroprevalence found in this study reiterates the importance of addressing the HCV burden in both Rwanda and in Sub-Saharan Africa. Risk factors identified in this study, including older age, lower socioeconomic status, geographic variation, history of traditional surgical practices, and family exposures present opportunities to target high risk individuals for both prevention and screening as Rwanda commits to achieving WHO targets of eliminating HCV by 2030.

List Of Abbreviations

CI: Confidence Interval

CRF: Chronic Renal Failure

ELISA: Enzyme-Linked Immunosorbent Assays

HBV: hepatitis B virus

HCV: Hepatitis C Virus

HCV Ab: Hepatitis C Virus Antibody

HIV/AIDS: Human Immunodeficiency virus/ Acquired Immunodeficiency Diseases Syndrome

MEDIPLAN: Private insurance initiated by Insurance Company called SORAS

MMI: Military Medical Insurance

MINALOC: Ministry of Local Government

OR: Odd Ratio

PLHIV: People Living with HIV

RAMA: La Rwandaise Assurance Maladie: Health insurances for employees of public and private sectors

RBC: Rwanda Biomedical Center

SPSS: Statistical Package for the Social Sciences

TB: Tuberculosis

WHO: World Health Organization

Declarations

Ethics and consent to participate: The ethical procedures for the collection of these data were governed by the Medical Research Council of Rwanda and site authorizations were obtained from the Ministry of Health for hosting sites. Secondary analyses of routinely collected data are exempt by the Rwanda Biomedical Center.

Consent for publication:

Not Applicable

Availability of data and materials

The datasets generated during the current study are not publicly available but are available from the corresponding author on reasonable request.

Conflict of Interest

This study used routine data collected by Rwanda Biomedical center, there is no conflict of interest with any person

Funding: The Screening of hepatitis B virus was funded by the Government of Rwanda.

Contributors

MJD, CJL, NCK, UJ, DD, DSM, JS, MS and SN developed the study protocol and study design. MJD, CJL, NCK, UJ, DD and JS collected the data. MJD did the data analysis and developed the figure and tables. All authors participated in interpretation of the data. MJD did the literature review and wrote the first draft of the manuscript. All authors reviewed and provided critique of the manuscript.

Conflict of Interest

This study used routine data collected by Rwanda Biomedical center, there is no conflict of interest with any person

References

1. World Health Organization. *Global hepatitis report, 2017*. (2017). doi:ISBN 978-92-4-156545-5

2. Bartenschlager, R. *et al.* Critical challenges and emerging opportunities in hepatitis C virus research in an era of potent antiviral therapy: Considerations for scientists and funding agencies. *Virus Res.* 248, 53–62 (2018).

3. Petruzziello, A., Marigliano, S., Loquercio, G., Cozzolino, A. & Cacciapuoti, C. Global epidemiology of hepatitis C virus infection: An up-date of the distribution and circulation of hepatitis C virus genotypes. *World J. Gastroenterol.* 22, 7824–7840 (2016).

4. Cornberg, M. *et al.* A systematic review of hepatitis C virus epidemiology in Europe , Canada and Israel. 30–60 (2011). doi:10.1111/j.1478-3231.2011.02539.x

5. Shiferaw, F., Letebo, M. & Bane, A. Chronic viral hepatitis: policy, regulation, and strategies for its control and elimination in Ethiopia. *BMC Public Health* 16, 1–13 (2016).

6. Mercy Jelagat Karoney, A. M. S. Hepatitis C virus (HCV) infection in Africa : a review. *Pan Afr. Med. J.* 8688, 1–8 (2013).

7. J.C., E. *et al.* Prevalence and risk factors for hepatitis c and human immunodeficiency virus coinfection among children in Enugu Nigeria. *African J. Infect. Dis.* 8, 5–8 (2014).

8. Semugoma, N. P. *et al.* Hepatitis C: A South African literature review and results from a burden of disease study among a cohort of drug-using men who have sex with men in Cape Town, South Africa. *South African Med. J.* 107, 1116 (2017).

9. Mutagoma, M. *et al.* Hepatitis C virus and HIV co-infection among pregnant women in Rwanda. *BMC Infect. Dis.* 17, 4–9 (2017).

10. Umutesi, J. *et al.* Prevalence of hepatitis B and C infection in persons living with HIV enrolled in care in Rwanda. *BMC Infect. Dis.* 17, 1–7 (2017).

11. Gorar, Z. A., Butt, Z. A. & Aziz, I. Risk factors for bloodborne viral hepatitis in healthcare workers of Pakistan: A population based case-control study. *BMJ Open* 4, 1–7 (2014).

12. Hayes, M. O. & Harkness, G. A. Body piercing as a risk factor for viral hepatitis: an integrative research review. *Am. J. Infect. Control* 29, 271–274 (2001).

13. Mohamed, H. I. *et al.* Hepatitis C, hepatitis B and HIV infection among Egyptian prisoners: Seroprevalence, risk factors and related chronic liver diseases. *J. Infect. Public Health* 6, 186–195 (2013).

14. Huang, C. *et al.* Prevalence and risk factors of hepatitis C among former blood donors in rural China. *Int. J. Infect. Dis.* 16, e731–e734 (2012).

15. Degenhardt, L. *et al.* Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. *Lancet Glob. Heal.* 5, e1192–e1207 (2017).

16. Mbituyumuremyi, A. *et al.* Controlling hepatitis C in Rwanda: a framework for a national response. *Bull. World Health Organ.* 96, 51–58 (2018).

17. National Institute of Statistics of Rwanda (NISR), M. of F. and E. P. (MINECOFIN) [Rwanda]. Rwanda Household, Integrated Survey, Living Conditions. (2015).

18. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and I. I. *Rwanda Demographic and Health Survey 2014-15*. (NISR, MOH,and ICF International, 2015).

19. Hajiani, E., Masjedizadeh, R., Hashemi, J., Azmi, M. & Rajabi, T. Hepatitis C virus transmission and its risk factors within families of patients infected with hepatitis C virus in southern Iran: Khuzestan. *World J. Gastroenterol.* 12, 7025–7028 (2006).

20. Zekry Farg, I., El-Dien Nouh, M. & AlFateh Mahrous, O. Intrafamilial transmission of hepatitis C virus in Menoufia Governorate. *Menoufia Medical Journal* 27, 478 (2014).

21. Amran B. Lankarani, Maryam Ardebili, Masood Sepehrimanesh, Maryam Nejabat, M. A. & Hemmati Rad, S. Y. H. Evaluation of hepatitis C virus intrafamilial transmission among in Iran. *Gastroenterol Hepatol Bed Bench* 9, 250–258 (2016).

22. Omar, M. Z. *et al.* Role of intrafamilial transmission in high prevalence of hepatitis C virus in Egypt. *Hepatic Med. Evid. Res.* 9, 27–33 (2017).

23. Paez Jimenez, A. *et al.* HCV iatrogenic and intrafamilial transmission in Greater Cairo, Egypt. *Gut* 59, 1554–1560 (2010).

24. Bi-fen Luo, Hui-ying Rao, Y. G. and L. W. Risk factors for familial clustering of hepatitis C virus infection in a Chinese Han population: a cross-sectional study. *BMC Public Health* 18, 708 (2018).

25. Rwanda Ministry of Health, W. H. O. *Rwanda Non-communicable Diseases Risk Factors Report*. *WHO* (2015).

26. Latt, N., Alachkar, N. & Gurakar, A. Hepatitis C virus and its renal manifestations: A review and update. *Gastroenterol. Hepatol.* 8, 434–445 (2012).

Tables

Table 1. General characteristics of participants

Characteristics	Frequency	Percent
Gender(N=326175)		
Female	224382	68.8
Male	101793	31.2
Age group(N=317431)		
<35 years old	92243	29.1
35-44 years old	79651	25.1
45-54 years old	61905	19.5
55-64 years old	50556	15.9
65 years old and above	33076	10.4
Marital status(N=319302)		
Married	247437	77.5
Single	28188	8.8
Widow, Divorced and Separated	43677	13.7
Ubudehe category(N=318855)		
Category 1	49886	15.6
Category 2	119643	36.5
Category 3	149092	45.5
Category 4	234	.1
Health Insurance(N=323953)		
Mutuelle	303206	93.6
RAMA	14708	4.5
MMI	2574	.8
Other private insurances	3465	1.1
Province of screening(N=315040)		
East	110337	35.0
North	65824	20.9
West	89885	28.5
South	48994	15.6

Table 2. Distribution of potential self-reported risk factors for hepatitis C that were assessed in the analysis

Characteristics	Frequency	Percent
Suffering from Diabetes(N=326926)		
No	325059	99.40
Yes	1867	0.60
Suffering from HBP (N=326931)		
No	317421	97.10
Yes	9510	2.90
Suffering from CRF(N=326930)		
No	326323	99.80
Yes	578	0.20
Suffering from Cancer (N=326901)		
No	32016	98.00
Yes	293	0.19
HIV status (N=326913)		
Negative	320316	98.00
Yes	6597	2.00
Ever had TB(N=326919)		
No	326581	99.90
Yes	338	0.10
Ever been operated(N=326913)		
No	309037	94.40
Yes	17876	5.60
Ever been transfused(N=326922)		
No	321572	98.40
Yes	5350	1.60
Traditional operation and scarification(N=326652)		
No	272555	79.51
Yes	54097	16.60
Having more than 1 sexual partner(N=326785)		
No	318030	97.30
Yes	8755	2.70
Viral Hepatitis in the family(N=326882)		
No	320692	98.10
Yes	6190	1.90

Table 3. Prevalence of HCV according to different characteristics among participants

Characteristics	Frequency	HCV positive(%)	Bivariate analysis			Multivariate analysis		
			OR	(95%CI)	P-value	OR	(95%CI)	P-value
Gender(N=325078)								
Female	223627	15431(6.9)	1			1		
Male	101451	6651(6.6)	0.947	(0.919-0.975)	<0.001	1.063	(1.028-1.100)	<0.001
Age group(N=316336)								
<35 years old	91922	3396(3.7)	1			1		
35-44 years old	79337	3427(4.3)	1.177	(1.121-1.235)	<0.001	1.108	(1.053-1.166)	<0.001
45-54 years old	61733	3516(5.7)	1.574	(1.500-1.652)	<0.001	1.295	(1.229-1.365)	<0.001
55-64 years old	50379	4674(9.3)	2.666	(2.547-2.790)	<0.001	2.105	(2.00-2.216)	<0.001
65 years old and above	32965	6458(19.6)	6.351	(6.079-6.635)	<0.001	4.857	(4.617-5.110)	<0.001
Marital status (N=318211)								
Single	28105	1030(3.7)	1			1		
Married	246593	15266(6.2)	1.735	(1.627-1.850)	<0.001	1.152	(1.074-1.236)	<0.001
Widow, separated and divorced	43513	4866(11.2)	3.31	(3.089-3.546)	<0.001	1.36	(1.257-1.471)	<0.001
Ubudehe category(N=318784)								
Category 1	49767	4462(9.0)	1			1		
Category 2	119347	8034(6.7)	0.733	(0.705-0.761)	<0.001	0.966	(0.927-1.008)	0.112
Category 3	148452	9097(6.1)	0.663	(0.639-0.688)	<0.001	0.919	(0.881-0.959)	<0.001
Category 4	234	17(7.3)	0.795	(0.485-1.304)	0.364	1.351	(0.812-2.247)	0.247
Health Insurance(N=322856)								
Mutuelle	302152	21095(7.0)	1			1		
RAMA	14673	515(3.5)	0.485	(0.443-0.530)	<0.001	0.775	(0.704-0.854)	<0.001
MMI	2570	78(3.0)	0.417	(0.333-0.523)	<0.001	0.804	(0.633-1.022)	0.075
Other private insurances	3436	218(6.3)	0.896	(0.780-1.028)	0.117	1.057	(0.909-1.230)	0.471

Province of screening(N=313945)								
North	65804	3313(5.0)	1			1		
West	89767	5277(5.9)	1.178	(1.127-1.232)	<0.001	1.192	(1.137-1.249)	<0.001
South	48976	5880(12.0)	2.574	(2.462-2.690)	<0.001	1.978	(1.884-2.077)	<0.001
East	109398	7264(6.6)	1.342	(1.399-1.399)	<0.001	1.369	(1.309-1.432)	<0.001
Suffering from Diabetes(N=325829)								
No	323971	21961(6.8)	1.000			1.000		
Yes	1858	182(9.8)	1.493	(1.281-1.741)	<0.001	1.006	(0.853-1.186)	0.942
Suffering from HBP (N=325834)								
No	316372	21054(6.7)	1.000			1.000		
Yes	9462	1090(11.5)	1.826	(1.712-1.948)	<0.001	1.217	(1.133-1.308)	<0.001
Suffering from CRF(N=325833)								
No	321698	21692(6.7)	1.000			1.000		
Yes	4135	452(10.9)	1.697	(1.538-1.873)	<0.001	1.291	(1.156-1.443)	<0.001
Suffering from Cancer (N=325804)								
No	325228	22079(6.8)	1.000			1.000		
Yes	513	63(10.9)	1.686	(1.298-2.191)	<0.001	1.234	(0.918-1.660)	0.164
HIV status (N=325816)								
Negative	319234	21673(6.8)	1.000			**1**		
Yes	6582	470(7.1)	1.056	(0.960-1.161)	0.262	**1.078**	(1.049-1.318)	0.001
Ever had TBC(N=325822)								
No	325484	22108(6.8)	1.000			1.000		
Yes	338	36(10.7)	1.636	(1.158-2.312)	0.005	1.435	(0.987-2.086)	0.059
Ever been operated(N=325816)								
No	307980	20916(6.8)	1.000					
Yes	17836	1225(6.9)	1.012	(0.953-1.074)	0.692			

Ever been transfused(N=325825)								
No	320488	21691(6.8)	1.000			1.000		
Yes	5337	452(8.5)	1.275	(1.158-1.405)	<0.001	1.081	(0.971-1.203)	0.153
Traditional operation and scarifications (N=325555)								
No	271590	18047(6.6)	1.000			1.000		
Yes	53965	4089(7.6)	1.152	(1.112-1.193)	<0.001	1.091	(1.049-1.135)	<0.001
Having more than 1 sexual partner(N=325688)								
No	316954	21601(6.8)	1.000			1.000		
Yes	8734	538(6.2)	0.898	(0.822-0.980)	0.016	0.934	(0.849-1.027)	0.161
Viral Hepatitis in the family(N=325785)								
No	319616	21609(6.8)	1.000			1.000		
Yes	6169	531(8.6)	1.299	(1.187-1.421)	<0.001	1.268	(1.151-1.397)	<0.001

Figures

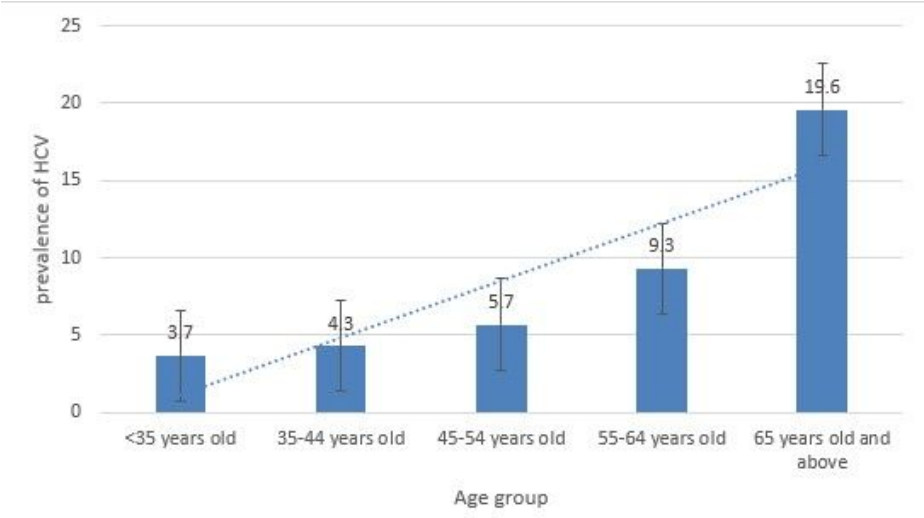

Figure 1

Prevalence of HCVAb by age category of participants

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplement1.docx