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RESEARCH PAPER

TITLE

PREVALENCE OF HEPATITIS C VIRUS (HCV) IN TERTIARY CARE HOSPITAL

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PREVALENCE OF HEPATITIS C VIRUS (HCV) IN TERTIARY CARE HOSPITAL

ABSTRACT

Hepatitis C is a significant public health concern across worldwide, especially in Pakistan. Understanding the prevalence of the disease at the regional level is crucial for effective prevention and control measures. In this study, we collected demographic information from study participants, including age, gender, marital status, and, other relevant variables, and also administered a structured questionnaire to know the history of the patient. We used hepatitis C kits to identify the hepatitis virus in patients. In our research, we took a sample of 329 people out of which 31 were positive and 298 were negative. Out of total 329 people,170 were male patients and 159 patients were female. To calculate the overall prevalence of Hepatitis C based on the given sample data, number of positive cases 31 were divided by the total number of samples. Overall prevalence was 9% in Gujrat. Prevalence among Males was 7% while 10.6% among females. Our findings showed that the prevalence of HCV is alarmingly high in district Gujrat as compared to the rest of Pakistan. Prevalence of Hepatitis C among married in Gujarat, Pakistan is approximately 11.27% (30 out of 266 patients the overall prevalence of HCV in Pakistan is 6% while it's 9% in Gujrat). As a result, different levels of prevention are required for these fatal illnesses. Preventing Hepatitis C involves taking certain precautions to reduce the risk of transmission. Practice safe injection practices. Always use sterile needles and syringes and avoid sharing drug paraphernalia with others. This reduces the risk of HCV transmission through contaminated needles.

Keywords: Blood transfusion, Cirrhosis, HCV infection, Hepatitis C Virus, and Viral antigen

1. INTRODUCTION

HCV infection is a significant public health concern that affects approximately 71 million individuals globally. It is a leading cause of liver-related morbidity and mortality due to its association with liver fibrosis, cirrhosis, and liver cancer (Rauf et al., 2013). Unfortunately, each year, HCV causes an estimated 399,000 deaths worldwide, primarily caused by cirrhosis and hepatocellular carcinoma (Puchades Renau and Berenguer, 2018). HCV causes acute and chronic hepatitis infection. HCV is a worldwide predominant virus and a leading cause of death and illness (Messina et al., 2014). Persistent HCV disease is coincident with the progress of liver cirrhosis, liver failure, hepatocellular cancer, and death (Lauer and Walker, 2001). Approximately 60% to 80% of acute hepatitis infections persist and develop into chronic hepatitis C infections (Rabaan et al., 2020). Countless infected peoples, still, are unknown to the healthcare organization as they may be asymptomatic for years and have not been diagnosed with HCV (Mahmood et al., 2022). HCV is a type of virus that has a genetic material made of RNA, which is surrounded by an envelope. It belongs to the Flaviviridae family, which also includes other well-known viruses like the yellow fever virus, West Nile virus, and dengue virus. The virus particles are roughly spherical and have protruding spike-like projections on their surface.

They vary in size, with a diameter ranging from 40 to 100 nanometers. In contrast, exosomes, which are also found in culture media, are not present in purified virus preparations that have a high level of infectivity (Baharuddin et al., 2014). The genetic material of the virus called RNA encodes a single long protein that is then broken down by enzymes from the host and virus itself, resulting in ten different proteins, three of which make up the structure of the virus and seven are non-structural (Antonelli et al., 2014).

The proteins E1 and E2 form a glycoprotein complex that is present on the surface of the virus, which aids in entering liver cells. The E2 component contains the region that binds to receptors and interacts with two different proteins, scavenger- receptor class B1 and CD81. On the other hand, E1 is considered to be part of the protein responsible for fusing the virus with the host cell since it has a component called the putative fusion peptide. Since the E1E2 complex is the only viral protein present on the surface, it is an attractive target for developing broad-spectrum neutralizing antibodies, making it a promising candidate for designing immunogens based on its structure (Torrents de la Peña et al., 2022). The highest prevalence of chronic hepatitis C regions is in Africa and the east Mediterranean while the areas having a low prevalence of hepatitis C are, Australia, the Americas, and Western Europe (Shayan et al., 2021). In 1988, Michael Houghton's team isolated complementary DNA from the blood of a person infected with a "Non-A Non-B" virus, which allowed for the isolation of viral RNA and the rapid development of serological diagnostic tests. Elisa tests (EIA) and Radio-Immunoassays (RIA) were developed simultaneously, and their sensitivity and specificity have significantly improved over the years (Researchers have learned a lot about viral pathogenesis and the role of the Core, and this information can be valuable for studying less-characterized viruses (Kao et al., 2016). The discovery of HCV was a unique event in the history of microbiology. The virus was discovered relatively late, in 1988, after the first therapeutic trials had already begun. However, the development of the virus was swift, with remarkable progress made in the thirty years since its discovery (Pol and Lagaye, 2019). During this time, reciprocal interactions between the research and clinical fields led to the development of reliable serological and virologic diagnostic tests, effective treatments, and the implementation of policies aimed at eliminating the virus. The World Health Organization (WHO) has promoted the HCV elimination program, which has been adopted by at least 12 countries worldwide. This program aims to reduce new infections by 30% in 2020 and 90% in 2030, while also reducing hepatitis-related mortality by 10% and 65%, respectively. Nearby 20-25% of people infected with HCV experience an acute infection, which may not show symptoms or only cause mild symptoms such as malaise, jaundice, nausea, and pain that can persist for several months (Pol and Lagaye, 2019)). During this time, the liver enzyme alanine aminotransferase may also be released. However, the majority of HCV patients will develop a chronic infection that can lead to liver inflammation, steatosis, fibrosis, cirrhosis, and even (HCC) over the span of many years. HCV infection is also associated with insulin resistance and Type 2 diabetes mellitus. Effective

and well-tolerated treatments that specifically target HCV replication have become available in recent years, such as direct-acting antivirals that can be administered alongside other therapies (Velásquez, 2017, Timm et al., 2004). The current standard treatment for chronic hepatitis C infection involves a combination of PEGylated interferon alfa and ribavirin. This therapy was chosen based on the findings of three important clinical trials that showed its superiority over the previous standard treatment of interferon alfa and ribavirin. These trials helped to define key elements of the treatment, such as the optimal dosing of the drugs, the length of treatment needed, and the need for different regimens for patients with different genotypes of the virus (Ghany et al., 2009). Until recently, interferon alfa and ribavirin have been the primary treatment for HCV. However, new direct-acting antivirals have been developed that are designed to specifically inhibit three viral proteins (Kimer et al., 2012). This study was conducted to observed the Hepatitis C prevalence in Gujrat.

2. MATERIALS AND METHODS

In this study, we checked the prevalence of HCV in District Gujrat, Pakistan. The following research methodology was followed. We conducted a cross-sectional study to determine the prevalence of HCV in Gujrat Pakistan and we used a case-control study to identify risk factors associated with HCV. Our Ji study included 329 patients out of which 170 patients were male and 159 patients were female. Our research study duration was from 20th February 2023 to 25th May 2023 after the approval of research from the board. We used Non-probability Purposive Sampling in our research study. Participants were recruited into the study irrespective of gender. While patients HIV Co-infected, Transplant recipients, and Cancer patients were excluded from the study.

Ethical considerations were taken into account by us throughout the research process. Informed consent was obtained from participants, and confidentiality was maintained throughout the research process. Ethical considerations are crucial in any research study, and it's commendable that you took them into account throughout your research process. Obtaining informed consent from participants is a fundamental ethical requirement, ensuring that individuals are fully informed about the purpose. Procedures, potential risks, and benefits of the study before agreeing to participate. Maintaining confidentiality is another essential aspect of ethical research.

The results of the study could be disseminated through research articles, conferences, and community engagement. It was essential to disseminate the findings to the relevant stakeholders, including policymakers, healthcare providers, and the general public.

Our research study was conducted in Hospital. HCV Antibody Rapid Test Kit was used because of its advantages of High Accuracy.

The selection of a representative sample of the population was a crucial step in our research. Our sample size ranged from 300 to 350 patients, and we collected a sample of 329 patients. A stratified random sampling technique was used by us to select a representative sample of the population in Gujarat, Pakistan.

We collected data through various methods such as surveys, medical records, and laboratory tests. Surveys were also conducted by us to collect information on risk factors and demographic characteristics, while

medical records and laboratory tests provided us with information on the diagnosis, treatment, and outcomes of HCV.

We collected data by analyzing using statistical software, such as SPSS. Descriptive statistics were used by us to describe the characteristics of the population, while inferential statistics were used by us to test hypotheses related to the prevalence and risk factors of HCV.

3. RESULTS

Among the patients in Gujrat, Pakistan out of a total of 329 patients, only 31 tested positive for Hepatitis C, while the remaining 298 patients tested negative. Therefore, the prevalence of Hepatitis C in Gujrat, Pakistan is approximately 9% (31 out of 329 patients) (Table 1).

Table 1: Prevalence of Hepatitis C in Gujrat

Patients	Number of patients	Percentage
Positive patients	31	9%
Negative Patients	298	91%
Total Suspected Patients	329	100

Among the male patients in Gujarat, Pakistan, out of a total of 170 patients, 12 tested positive for Hepatitis C, while the remaining 158 patients tested negative. Therefore, the prevalence of Hepatitis C among males in Gujarat, Pakistan is approximately 7% (12 out of 170 patients) (Table 2).

Table 2: Gender-wise Prevalence of HCV in Patients

Gender	No.	+ve	-ve	%
Male	170	12	158	7%
Female	159	17	142	10.6 %

Among the female patients in Gujarat, Pakistan, out of a total of 159 patients, 17 tested positive for Hepatitis C, while the remaining 142 patients tested negative. Therefore, the prevalence of Hepatitis C among females in Gujarat, Pakistan is approximately 10.6% (17 out of 159 patients) (Table 3).

Table 3: Gender-wise prevalence of HCV

Gender	Percentage
Male	41%
Female	59%

Among the patients aged between 0 to 10, none of them tested positive for Hepatitis C. Therefore, the prevalence of Hepatitis C in this age group is zero. Among the patients aged between 11 to 20, out of a total of 29 patients, only 1 tested positive for Hepatitis C, while the remaining 28 patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 3.4% (1 out of 29 patients). Among the patients aged between 21 to 30, out of a total of 87 patients, only 5 tested positive for Hepatitis C, while the remaining 82 patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 5.7% (5 out of 87 patients). Among the patients aged between 31 to 40, out of a total of 51 patients, only 6 tested positive for Hepatitis C, while the remaining 45

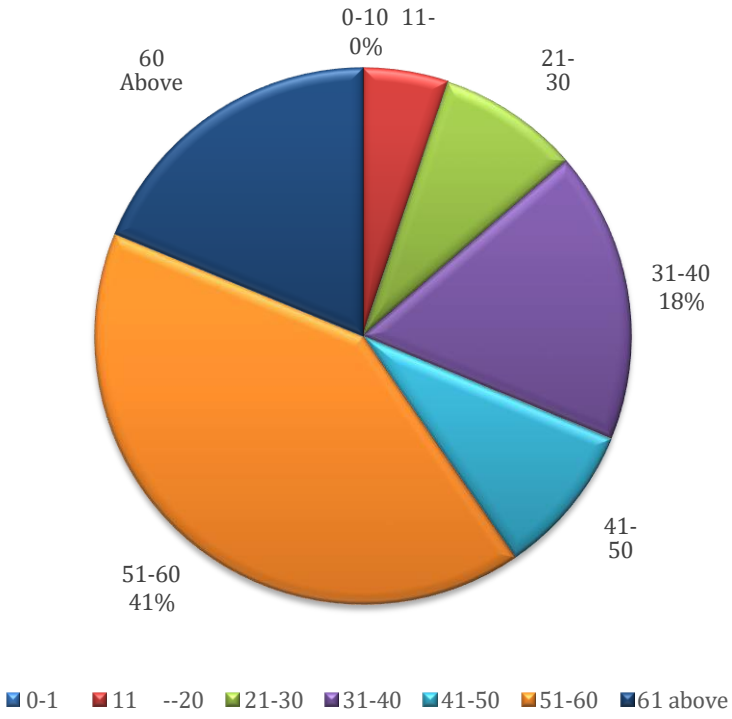
patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 11.7% (6 out of 51 patients) (Table 4).

Table 4: Age-wise prevalence of HCV

Age Duration	No. of Patients	Positive	Negative	Percentage
0-10	0	0	0	0%
11-20	29	1	28	3.4%
21-30	87	5	82	5.7%
31-40	51	6	45	11.7%
41-50	65	4	61	6.1%
51-60	33	9	24	27.2%
60 Above	48	6	42	12.5%

Among the patients aged between 41 to 50, out of a total of 65 patients, only 4 tested positive for Hepatitis C, while the remaining 61 patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 6.1% (4 out of 65 patients). Among the patients aged between 51 to 60, out of a total of 33 patients, only 9 tested positive for Hepatitis C, while the remaining 24 patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 27.2% (9 out of 33 patients). Among the patients aged 60 and Above, out of 48 patients, only 6 tested positive for Hepatitis C, while the remaining 42 patients tested negative. Therefore, the prevalence of Hepatitis C in this age group is approximately 12.5% (6 out of 48 patients) (Figure 1).

Figure 1: Age-wise prevalence of HCV



During March in Gujarat, Pakistan, out of a total of 155 patients, 14 tested positive for Hepatitis C, while the remaining 141 patients tested negative. Therefore, the prevalence of Hepatitis C in March in Gujarat, Pakistan is approximately 9% (14 out of 155 patients) (Table 5).

Table 5: Month-wise Prevalence

Month	Total Patients	Positive	Negative	Percentage
March	155	14	141	9%
April	174	17	157	9.7%

During April in Gujarat, Pakistan, out of 174 patients, 17 tested positive for Hepatitis C, while the remaining 157

patients tested negative. Therefore, the prevalence of Hepatitis C in April month in Gujarat, Pakistan is approximately 9.7% (17 out of 174 patients) (Figure 2).

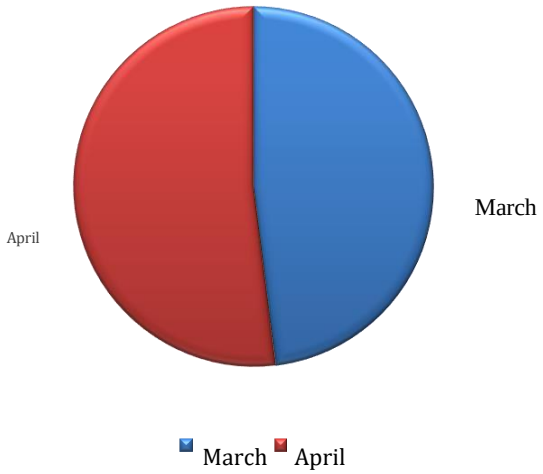


Figure 2: Month-wise prevalence of HCV

Among the married patients in Gujarat, Pakistan, out of 266 patients, 30 tested positive for Hepatitis C, while the remaining 236 patients tested negative. Therefore, the prevalence of Hepatitis C among married in Gujarat, Pakistan is approximately 11.27% (30 out of 266 patients.

Table 5: Prevalence of HCV in Married and Unmarried patients

Marital Status	No.	+ve	-ve	%
Married	266	30	236	11.27 %
Unmarried	63	1	62	1.58%

Among the un-married patients in Gujarat, Pakistan, out of 63 patients, only one test is positive for Hepatitis C, while the remaining 62 patients tested negative. Therefore, the prevalence of Hepatitis C among unmarried in Gujarat, Pakistan is approximately 1.58% (1 out of 63 patients) (Figure 3).

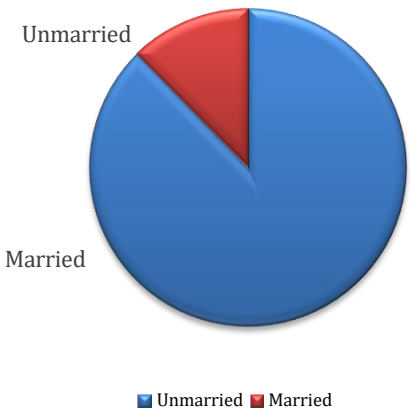


Figure 3: Prevalence of HCV in Married and Unmarried patients

4. DISCUSSION

The prevalence of hepatitis C virus (HCV) is a significant global health concern, affecting millions of people worldwide. According to the World Health Organization (WHO) estimated from 2019, approximately 71 million people were living with chronic HCV infection globally, indicating a substantial burden of the disease on a global scale. The high prevalence of HCV necessitates comprehensive prevention, diagnosis, and treatment efforts to address this public health challenge (Mir et al., 2020). In Pakistan, a significant number of individuals lack awareness regarding health issues, particularly regarding hepatitis B and C infections, largely due to a low literacy rate. Many patients infected with HBV and HCV are only diagnosed with hepatitis when they visit a doctor for unrelated health concerns, such as dental treatment or surgeries. Likewise, in our survey, a majority of patients were unaware of the disease and only discovered their diagnosis when they sought medical attention for other health issues (Khan et al., 2000). The improper reuse of needles and syringes is a significant pathway for HCV infection. According to a report by

the World Health Organization (WHO), approximately 16 billion injections are administered annually in developing countries, with a majority of them being inadequately sterilized (Khan et al., 2000). In Pakistan, it is estimated that 71% of the population, encompassing both rural and urban areas, view injections as the quickest method to alleviate pain, resulting in the excessive use of needles (Khan et al., 2000). Moreover, a study has revealed the involvement of a small group of individuals in the distribution of unsterilized syringes. This situation poses a challenge for the general public as distinguishing between new, recycled, or unsterilized needles and syringes becomes difficult (Janjua et al., 2006). Regionally, HCV prevalence can vary significantly. Certain areas, such as Egypt, have particularly high rates of HCV, with estimates suggesting that 10-15% of the population is infected. Egypt has the highest recorded prevalence of hepatitis C virus (HCV) infection worldwide (Gomaa et al., 2017). This fact became evident soon after the discovery of HCV, particularly among Egyptian blood donors in the Kingdom of Saudi Arabia, where the seroprevalence was significantly higher compared to donors of other nationalities (Saeed et al., 1991). It was subsequently recognized that HCV infection was widespread among the Egyptian population and emerged as the primary cause of liver disease in the country. Prior to the recognition of the HCV epidemic, schistosomiasis was the predominant public health concern in Egypt (Abdel-Ghaffar et al., 2015). Pakistan also has a high prevalence of HCV, ranging from 4-6%. These numbers highlight the urgent need for targeted interventions and awareness campaigns in these regions to combat the burden of HCV effectively (Shayan et al., 2021). In Asia, the prevalence of HCV varies across different countries. For example, China has an estimated HCV prevalence of 1-2%, while Japan has a relatively lower prevalence of 0.3-1%. Iran's prevalence ranges from 0.2-2%, and Bangladesh has an estimated prevalence of 1-2%. These variations reflect the complex nature of HCV transmission and the diverse risk factors across different populations and regions. It underscores the importance of tailored prevention and control strategies that consider the specific dynamics of each country (Pawlotsky, 2014). Within Pakistan itself, HCV prevalence varies by province. Punjab, the largest province, has an estimated prevalence of 6-7%, while Sindh ranges from 4-6%. Khyber Pakhtunkhwa and Balochistan have prevalence rates of 2-3%, and Gilgit-Baltistan has a lower prevalence of 0.5-1%. These provincial variations necessitate targeted interventions and awareness campaigns at the regional level to effectively address the burden of HCV (Umer and Iqbal, 2016). Research conducted in Gujarat in 2019-20 indicated a prevalence of 5% for HepatitisC. However, your study conducted in 2023 observed an increased prevalence of Hepatitis C, which was found to be 9%. This highlights the dynamic nature of disease prevalence and the need for ongoing surveillance and research to monitor and respond to changes effectively (Nikitha et al., 2019). To address the burden of HCV in Pakistan, comprehensive strategies are required. Prevention programs, including harm reduction measures for high-risk populations such as injecting drug users, safe blood transfusion practices, and infection control in healthcare settings, are crucial. Increased access to testing and diagnosis is vital for identifying individuals with HCV, allowing for early intervention and treatment. Improvements in treatment options, including the availability of direct-acting antiviral medications, have significantly increased the chances of a cure for HCV infection (Organization, 2017). In 2016, the World Health Assembly made a commitment

to eliminate hepatitis C virus as a significant public health threat by the year 2030. This ambitious goal requires that 90% of all hepatitis C patients be diagnosed promptly and that approximately 80% of eligible patients receive treatment using direct-acting antivirals (Organization, 2017) Pakistan, being home to the second-largest burden of hepatitis C worldwide, has a prevalence rate of 4.8% across the country (Tunio et al., 2013). Efforts to raise awareness and provide education about HCV transmission, prevention, and treatment are essential to combat stigma, promote testing, and ensure early diagnosis. Implementation of evidence-based interventions, such as needle and syringe programs, medication-assisted therapy for substance use disorders, and targeted screening in high-risk populations, can contribute to reducing the impact of HCV on individuals and communities (Alter, 2002).

5. CONCLUSION

Our findings showed that the prevalence of HCV is alarmingly high in district Gujrat as compared to the rest of Pakistan. The overall prevalence of HCV in Pakistan is 6% while it's 9% in Gujrat. HCV infection transmission, and they can transfer diseases to the community through risky behavior such as syringe exchange, using of Barber unsafe blades, and unsafe sex. As a result, different levels of prevention are required for these fatal illnesses. Preventing Hepatitis C involves taking certain precautions to reduce the risk of transmission. Here are some key prevention steps. If you use injection drugs, avoid sharing needles, syringes, or any other drug paraphernalia. Use sterile equipment for each injection, and consider seeking help for substance abuse to reduce the risk of exposure to hepatitis C and other blood-borne infections. Hepatitis C can be transmitted through sexual contact, although the risk is relatively low compared to other sexually transmitted infections. To reduce the risk, use barrier methods such as condoms consistently and correctly, especially if you have multiple sexual partners or engage in high-risk sexual behaviors.

To prevent the transmission of Hepatitis C, take the following key recommendation: Avoid sharing needles, syringes, or any drug paraphernalia if you use injection drugs. Use sterile equipment for each injection and consider seeking help for substance abuse. Use barrier methods like condoms consistently and correctly during sexual activity, especially if you have multiple partners or engage in high-risk sexual behaviors. Ensure that piercings or tattoos are done by reputable professionals who follow proper sterilization techniques and use sterile equipment for each client. When visiting healthcare facilities, make sure medical personnel follow infection control practices, such as using sterilized equipment and proper hand hygiene.

REFERENCES

ABDEL-GHAFFAR, T. Y., SIRA, M. M. & EL NAGHI, S. 2015. Hepatitis C genotype 4: the past, present, and future. *World journal of hepatology,* 7**,** 2792.

ALTER, M. J. 2002. Prevention of spread of hepatitis C. *Hepatology,* 36**,** s93-s98.

ANTONELLI, A., FERRARI, S. M., GIUGGIOLI, D., DI DOMENICANTONIO, A., RUFFILLI, I., CORRADO, A., FABIANI, S., MARCHI, S., FERRI, C. & FERRANNINI, E. 2014. Hepatitis C virus infection and type 1 and type 2 diabetes mellitus. *World journal of diabetes,* 5**,** 586.

BAHARUDDIN, A., AMIR HASSAN, A., CHYE SHENG, G., BAKHTIAR NASIR, S., OTHMAN, S., YUSOF, R., OTHMAN, R. & ABDUL RAHMAN, N. 2014. Current

approaches in antiviral drug discovery against the Flaviviridae family. *Current pharmaceutical design,* 20**,** 3428-3444.

GHANY, M. G., STRADER, D. B., THOMAS, D. L. & SEEFF, L. B. 2009. Diagnosis, management, and treatment of hepatitis C: an update. *Hepatology (Baltimore, Md.),* 49**,** 1335.

GOMAA, A., ALLAM, N., ELSHARKWAY, A., EL KASSAS, M. & WAKED, I. 2017. Hepatitis C infection in Egypt: prevalence, impact and management strategies. *Hepatic medicine: evidence and research***,** 17-25.

JANJUA, N. Z., HUTIN, Y. J., AKHTAR, S. & AHMAD, K. 2006. Population beliefs about the efficacy of injections in Pakistan's Sindh province. *Public health,* 120**,** 824-833.

KAO, C. C., YI, G. & HUANG, H.-C. 2016. The core of hepatitis C virus pathogenesis. *Current opinion in virology,* 17**,** 66-73.

KHAN, A. J., LUBY, S. P., FIKREE, F., KARIM, A., OBAID, S., DELLAWALA, S., MIRZA, S., MALIK, T., FISHER-HOCH, S. & MCCORMICK, J. B. 2000. Unsafe injections and the transmission of hepatitis B and C in a periurban community in Pakistan. *Bulletin of the World Health Organization,* 78**,** 956-963.

KIMER, N., DAHL, E. K., GLUUD, L. L. & KRAG, A. 2012. Antiviral therapy for prevention of hepatocellular carcinoma in chronic hepatitis C: systematic review and meta-analysis of randomised controlled trials. *BMJ open,* 2.

LAUER, G. M. & WALKER, B. D. 2001. Hepatitis C virus infection. *New England journal of medicine,* 345**,** 41-52.

MAHMOOD, F., BABAR, N., ALI, Y., KOUSAR, K., AHMED, S. & KHAN, Z. U. 2022. Evaluation of Hepatitis C Virus and Hepatitis B Virus infection in Drug Abusers. *Pakistan Journal of Medical & Health Sciences,* 16**,** 640-640.

MESSINA, J. P., HUMPHREYS, I., FLAXMAN, A., BROWN, A., COOKE, G. S., PYBUS, O. G. & BARNES, E. 2014. Global distribution and prevalence of hepatitis C virus genotypes. *Hepatology,* 61**,** 77-87.

MIR, F., MAHMOOD, F., SIDDIQUI, A. R., BAQI, S., ABIDI, S. H., KAZI, A. M., NATHWANI, A. A., LADHANI, A., QAMAR, F. N. & SOOFI, S. B. 2020. HIV infection predominantly affecting children in Sindh, Pakistan, 2019: a cross-sectional study of an outbreak. *The Lancet Infectious Diseases,* 20**,** 362-370.

NIKITHA, S., SABEENA, S., ROBIN, S., HIREN, D., PRASAD, V., ASWATHYRAJ, S., DEVADIGA, S., ANUP, J. & ARUNKUMAR, G. 2019. The prevalence of anti-hepatitis C antibody among acute febrile illness cases in Idar Taluk, Gujarat, West India. *Indian journal of medical microbiology,* 37**,** 225-229.

ORGANIZATION, W. H. 2017. *Global hepatitis report 2017,* World Health Organization.

PAWLOTSKY, J. M. 2014. New hepatitis C therapies: the toolbox, strategies, and challenges. *Gastroenterology,* 146**,** 1176-1192.

POL, S. & LAGAYE, S. 2019. The remarkable history of the hepatitis C virus. *Genes & Immunity,* 20**,** 436-446.

PUCHADES RENAU, L. & BERENGUER, M. 2018. Introduction to hepatitis C virus infection: Overview and history of hepatitis C virus therapies. *Hemodialysis International,* 22**,** S8-S21.

RABAAN, A. A., AL-AHMED, S. H., BAZZI, A. M., ALFOUZAN, W. A., ALSULIMAN, S. A., ALDRAZI, F. A. & HAQUE, S. 2020. Overview of hepatitis C infection, molecular biology, and new treatment. *Journal of infection and public health,* 13**,** 773-783.

RAUF, A., NADEEM, M. S., ARSHAD, M., RIAZ, H., LATIF, M. M., IQBAL, M., LATIF, M. Z., NISAR, A. & SHAKOORI, A. R. 2013. Prevalence of hepatitis B and C virus in the general population of Hill Surang area, Azad Jammu and Kashmir, Pakistan. *Pakistan Journal of Zoology,* 45.

SAEED, A., AL-ADMAWI, A., AL-RASHEED, A., FAIRCLOUGH, D., BACCHUS, R., RING, C. & GARSON, J. 1991. Hepatitis C virus infection in Egyptian volunteer blood donors in Riyadh. *The Lancet,* 338**,** 459-460.

SHAYAN, S. J., NAZARI, R. & KIWANUKA, F. 2021. Prevalence of HIV and HCV among injecting drug users in three selected WHO-EMRO countries: a meta-analysis. *Harm reduction journal,* 18**,** 59.

TIMM, J., LAUER, G. M., KAVANAGH, D. G., SHERIDAN, I., KIM, A. Y., LUCAS, M., PILLAY, T., OUCHI, K., REYOR, L. L. & ZUR WIESCH, J. S. 2004. CD8 epitope escape and reversion in acute HCV infection. *The Journal of experimental medicine,* 200**,** 1593-1604.

TORRENTS DE LA PEÑA, A., SLIEPEN, K., ESHUN-WILSON, L., NEWBY, M. L., ALLEN, J. D., ZON, I., KOEKKOEK, S., CHUMBE, A., CRISPIN, M. & SCHINKEL, J. 2022. Structure of the hepatitis C virus E1E2 glycoprotein complex. *Science,* 378**,** 263-269.

TUNIO, S. A., BANO, S., LAGHARI, Z. A., ALI, W., SHAMIM, H. & AFREEN, U. 2013. Seroprevalence of Hepatitis B and Hepatitis C among blood donors in Hyderabad, Pakistan. *Gomal Journal of Medical Sciences,* 11.

UMER, M. & IQBAL, M. 2016. Hepatitis C virus prevalence and genotype distribution in Pakistan: Comprehensive review of recent data. *World journal of gastroenterology,* 22**,** 1684.

VELÁSQUEZ, G. 2017. Access to hepatitis c treatment: a global problem. Research Paper.