INDUS JOURNAL OF BIOSCIENCE RESEARCH

Effects of Socioeconomic Factors and Smoking on Liver Fibrosis; A Case Study of Patients of Liver Fibrosis

Areha Arif[1], Arham Arif[2], Laiba Noor[3], Nazia Iram[4], Malka Saba Bashir[5], Zaigham Ishrat[6], Ainam Fatima[5], Sabika Khan[5], Atif Abbasi[7]

[1]Department of Biochemistry, Riphah International University, Faisalabad Campus, Punjab, Pakistan.
[2]Department of Bachelor of Medicine and Bachelor of Surgery, King Edward Medical University, Lahore, Punjab, Pakistan.
[3]Allied Health Professionals, Medical Laboratory Technology, Government College University, Faisalabad, Punjab, Pakistan.
[4]Institute of Zoology, Punjab University, Lahore, Punjab, Pakistan.
[5]Department of Zoology, The Women University Multan, Punjab, Pakistan.
[6]Department of Health, Nishter Medical University, Multan, Punjab, Pakistan.
[7]Department of Biochemistry, Hazara University, Mansehra, KP, Pakistan.

ARTICLE INFO

ABSTRACT

A serious health risk is liver fibrosis, which can manifest in different degrees of severity in people with a persistent Hepatitis C virus (HCV) infection. This study is critical because it looks at how poverty, smoking, and environmental variables affect how people with HCV manage their liver illness. The study intends to evaluate the influence of various environmental and socioeconomic factors on the course of the disease by examining the natural history of liver fibrosis. A standardized questionnaire was created to collect information from 100 patients with Hepatitis C-related liver fibrosis. The results showed a strong correlation between the onset of liver fibrosis and extended periods of poverty. Furthermore, significant associations were found between advanced stages of liver fibrosis and environmental variables such as air pollution and occupational risks. The complicated and multifaceted character of liver fibrosis development in HCV patients is highlighted by this study, underscoring the necessity of individualized therapy regimens that include various contributing variables. The findings thoroughly comprehend how environmental factors and socioeconomic status impact the treatment of liver disease. In order to better understand the underlying processes of liver fibrosis in this group, future research paths should integrate contemporary molecular and imaging tools. These methods might eventually direct public health campaigns to enhance patient outcomes and illness management, guaranteeing improved treatment plans for individuals impacted.

INTRODUCTION

Liver fibrosis is a progressive disease marked by an excessive build-up of extracellular matrix proteins, mainly collagen, which causes the liver to deteriorate structurally and functionally (Ortiz et al., 2021). Among the many factors that contribute to liver fibrosis, socioeconomic status (SES) and smoking have become important but little-studied determinants. Socioeconomic disparities, which include income, education, employment status, and access to healthcare, affect health outcomes by influencing dietary choices, healthcare use, and exposure to environmental toxins, while smoking has been well-researched for aggravating liver damage through oxidative stress, inflammation, and immune dysregulation (Singh et al., 2023). In order to provide vital information for clinical treatments and public health policy, this study aims to examine how these two variables, separately and jointly, affect the severity of liver fibrosis (Zein et al., 2011).

The influence of socioeconomic factors on liver fibrosis encompasses more than just direct access to healthcare; it also includes broader determinants like lifestyle choices, living conditions, and occupational hazards (Talens et al., 2021). People from lower socioeconomic backgrounds are more likely to suffer from poor nutrition, chronic stress, and limited access to healthcare, all of which increase the risk of developing

liver fibrosis. Chronic stress, for instance, has been associated with heightened systemic inflammation, which exacerbates fibrotic progression (Ho et al., 2014). Furthermore, financial constraints often result in delayed medical consultations, inadequate treatment adherence, and reliance on unregulated alternative therapies, worsening disease outcomes. By causing hepatocellular damage and hindering hepatic regeneration, smoking, a habit more common among people from lower socioeconomic categories, contributes to the acceleration of fibrosis (Jamalinia et al., 2024). Tobacco toxins further connect smoking to advanced liver disease by promoting hepatic stellate cell activation, a crucial step in the development of fibrosis. Despite these established dangers, most research on liver fibrosis has concentrated on metabolic and viral causes, ignoring the socioeconomic factors that influence the course of the disease (Sanyal et al., 2019).

Given the growing burden of liver disease globally, understanding the socioeconomic and behavioral determinants of liver fibrosis is essential for developing targeted interventions (Xiao et al., 2020). Public health efforts have traditionally prioritized viral hepatitis vaccination and treatment strategies, but a more comprehensive approach addressing lifestyle factors and social determinants is necessary. This research aims to bridge the gap by examining the correlation between SES, smoking habits, and liver fibrosis severity in a clinical population. We want to find evidence-based correlations through patient data analysis to guide early intervention and prevention plans (Youngstrom et al., 2015). In order to lessen the adverse effects of socioeconomic disparities on liver health, this study also emphasizes the necessity of multidisciplinary cooperation between social scientists, legislators, and healthcare professionals. The study adds to the larger conversation on liver disease prevention and management by comprehensively understanding these factors and highlighting the importance of incorporating social determinants into clinical practice and public health planning (Sears et al., 2012). The objective of this research is to examine the natural history of liver fibrosis in individuals with Hepatitis C while also evaluating the impact of smoking, environmental variables, and poverty on the disease's advancement in this particular population. Examine the smoking prevalence among individuals with chronic Hepatitis. Examine the relationship between the degree of liver fibrosis in patients with chronic Hepatitis C and socioeconomic characteristics, especially poverty. Evaluate the possible pathways via which the advancement of liver fibrosis may be influenced by socioeconomic status. Examine how smoking, climatic conditions, age, and poverty all affect the development of liver fibrosis.

MATERIAL AND METHODS
Study Design
This is a quantitative study designed to analyze liver fibrosis in Hepatitis C patients and the impact of poverty, smoking, and environmental factors on patients with liver fibrosis. This study aims to explore the natural history of liver fibrosis in individuals with Hepatitis C while also evaluating the impact of smoking, environmental variables, and poverty on the development of liver fibrosis in this population. This information can be used to identify gaps in knowledge and understanding and to develop interventions to improve the practices of individuals, public awareness, and health outcomes.

Study Duration
The total study duration was two months, from December 2023 to January 2024. This study targets male and female patients (up to 30 years of age and above) from THQ Fatehpur district Layyah of Pakistan, with a sample size of 50. We only filled out the questionnaire from patients with liver fibrosis in Hepatitis C patients.

Study setting
Pakistan's population, consisting of Punjab, Sindh, KPK, and Baluchistan, makes it the 33rd-largest nation in the world by area and the fifth-most populous country, with a population of over 249 million. Pakistan's Punjab Province is the most populous and second-largest in terms of land area. The study was carried out from Layyah, one of Pakistan's southern districts in Punjab.

Data Collection
Description of Data Collection Methods
The data collection methods used in this study were primarily through a structured questionnaire. The questionnaire was designed to obtain information about liver fibrosis in Hepatitis C patients and the effect of poverty, environmental factors, and smoking among patients of THQ in Fatehpur, province of Punjab. The questionnaire was closed-ended to capture a wide range of responses from the participants. Closed-ended questions provided response options.

Development of the Questionnaire
The questionnaire was created based on a comprehensive analysis of pertinent literature and previously approved tools utilized in comparable investigations. Next, we carefully considered and modified the questions to fit the target group and the particular setting of the study. The questions were written in plain, uncomplicated language to make them easy for the participants to grasp (Chan et al., 2022).

Statistical Analysis
The Statistical Software for the Social Sciences (SPSS) Version 26 was used to analyze the data gathered for the

study. Several analytical methods were used to extract significant insights from the data. Regression analysis was done to investigate the link between the study variables. In order to give a general picture of the knowledge, attitudes, and practices about the effects of smoking and socioeconomic factors on patients with liver fibrosis, descriptive analysis was used to compile the sample's characteristics. To evaluate the findings' statistical significance, the results' significance was ascertained. The data analysis procedure was carefully carried out to guarantee accurate and trustworthy results for interpretation and debate.

RESULTS

Liver fibrosis is one serious health concern. Liver fibrosis is an inflammatory reaction that the liver produces in response to an insult that damages the liver. If left unchecked, it can develop into cirrhosis and cause liver failure and cancer. Liver fibrosis arises from persistent liver damage, which can be brought on by viral infections, autoimmune disorders, metabolic disorders, and medication overuse; the impact of socioeconomic factors, including poverty, on delayed access to healthcare, was highlighted in this study. The questionnaire's results highlight socioeconomic barriers, like limited access to healthcare, that delay diagnosis and treatment initiation. This emphasizes treating socioeconomic factors that influence health when addressing hepatitis C. Two environmental factors contributing to liver fibrosis include chemical exposure and air pollution. Additionally, the research highlights the cumulative impacts of smoking. Positive and outstanding results are found in the study examining the effects of environmental factors on individuals with Hepatitis C and liver fibrosis. It discovers a connection between elevated liver fibrosis and exposure to pollutants and other environmental factors. This questionnaire-based approach helps us understand the natural history of liver fibrosis in Hepatitis C patients by collecting a range of patient experiences about the course of the disease, the efficacy of treatment, socioeconomic factors, environmental factors, smoking, monitoring practices, and general quality of life. Effective interventions to reduce the combined impact of these determinants on liver health should focus on socioeconomic factors, public awareness, and healthcare access.

Socioeconomic statuses

Of the 100 participants, the average age was 40-65, and the majority, 56.6%, were undergraduates, both males and females. According to our research, patients with Hepatitis C who have lower socioeconomic status (15.8%) also have faster liver fibrosis advancement.

Figure 1

Graph showing the household income of the patient
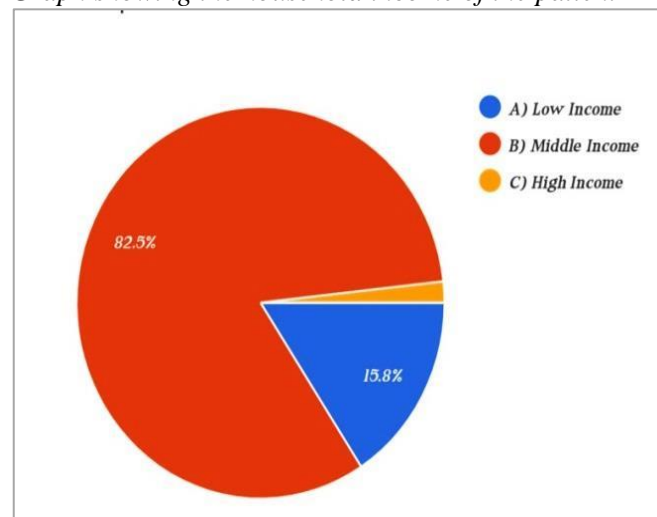
Advanced stages of fibrosis were exacerbated by patients with poor financial resources, with 45.6% having difficulty receiving prompt diagnosis and therapy, as shown in Fig 2. To enhance outcomes for this susceptible group, focused interventions targeting socioeconomic inequalities.

Figure 2

*Graph showing challenges of medical care due to financial constraints*
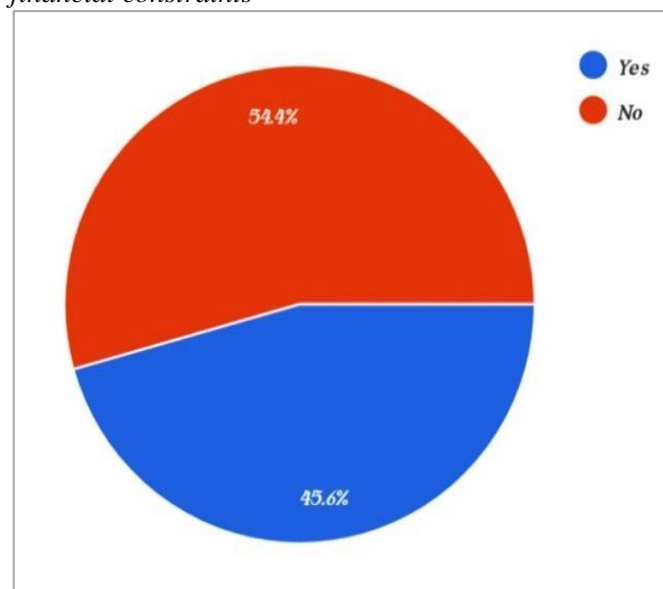
Evaluation of Environmental Factors on Liver Fibrosis

According to our research, environmental pollutants or toxins were linked to the development of liver fibrosis in Hepatitis C patients. 47.4% of patients had an effect of environmental pollutants and toxins on liver fibrosis, as described in Fig 4.3. Exposure to chemicals and pollutants in the environment exacerbates liver damage.

Figure 3

Graph of exposure to any environmental pollutants or toxins
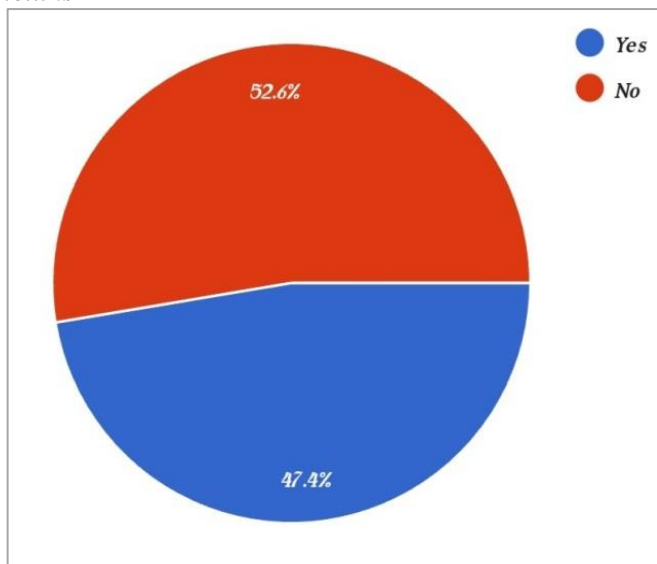
Unfavorable living circumstances, such as poor air quality (15.8% in our study in Fig 2), were associated with higher severity of liver fibrosis in Hepatitis C patients. Patients who reside in places with poor air quality suffer more damage to their livers which highlights the significance of taking environmental factors into account when developing methods for managing liver disease.

Figure 4

Graph of air quality in the living area
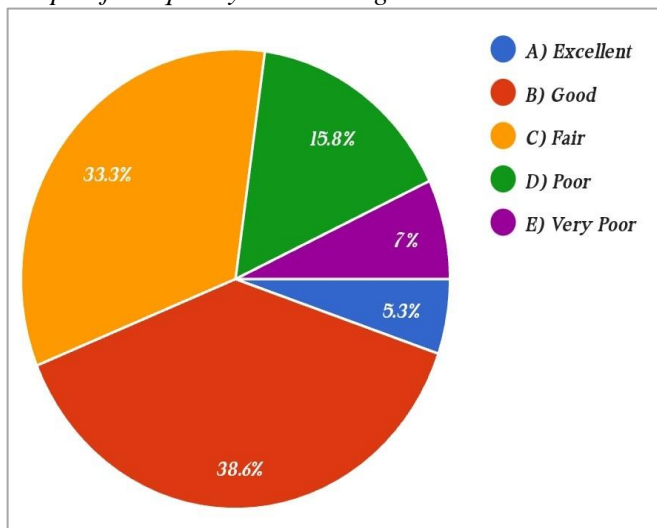
Studies show a significant correlation between workplace exposure to environmental risks and the development of liver fibrosis in Hepatitis C patients. Increased liver damage was a result of occupational exposure to chemicals and hazards, which emphasizes the importance of workplace safety measures in preventing liver fibrosis among at-risk populations, as shown in Figure 5.

Figure 5

Graph of any environmental Hazards at the workplace
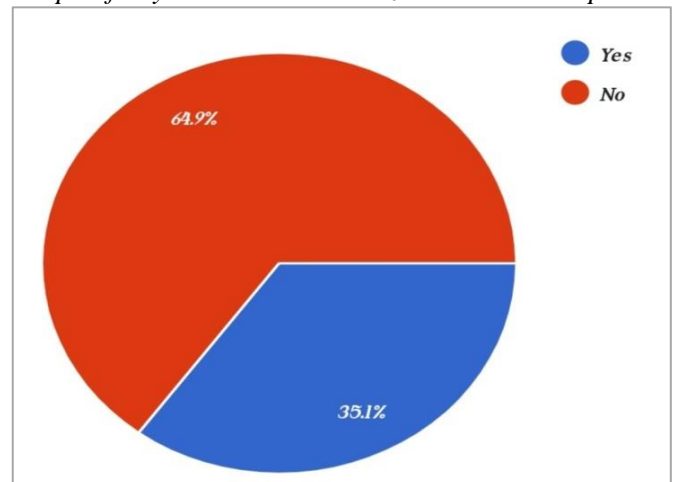
Our study reveals a troubling association between the degree of liver fibrosis in Hepatitis C patients and their work exposure to chemicals known to damage the liver in a percentage of 26 in our findings, as shown in Fig 6. We found that workers in settings with higher concentrations of chemicals that damage the liver had fibrosis that was more severe; for those who currently have Hepatitis C, occupational exposure to these drugs appears to worsen liver damage, which poses serious health risks. Strict occupational safety regulations are vital to protect liver health since those who are exposed to these environmental risks at work have a greater chance of experiencing accelerated liver damage.

Figure 6

Graph for working in an environment with liver-damaging substances
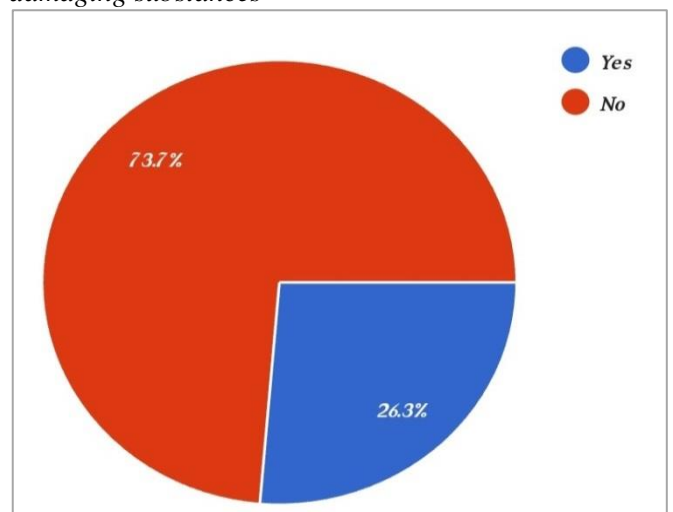
Smoking Association with Liver Fibrosis

We explore how smoking affects the development of liver fibrosis in Hepatitis C patients. Our results point to a significant correlation between smoking and a higher degree of liver fibrosis in 12.3% of smoking in the past and 7% of daily smokers. When compared to non-smokers, people with Hepatitis C who smoke may see an

acceleration in the advancement of liver damage. The detrimental consequences of tobacco smoking could lead to increased oxidative stress and inflammation in the liver, compounding the problems already caused by the viral infection. Comprehending the deleterious effects of smoking on liver health in this particular group is crucial for all-encompassing patient care, underscoring the significance of smoking cessation therapies as an integral component of comprehensive approaches to manage and alleviate hepatic fibrosis in Hepatitis C patients.
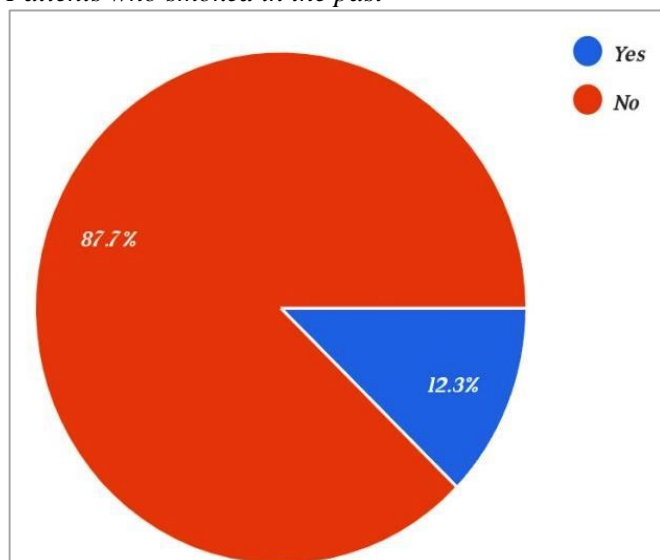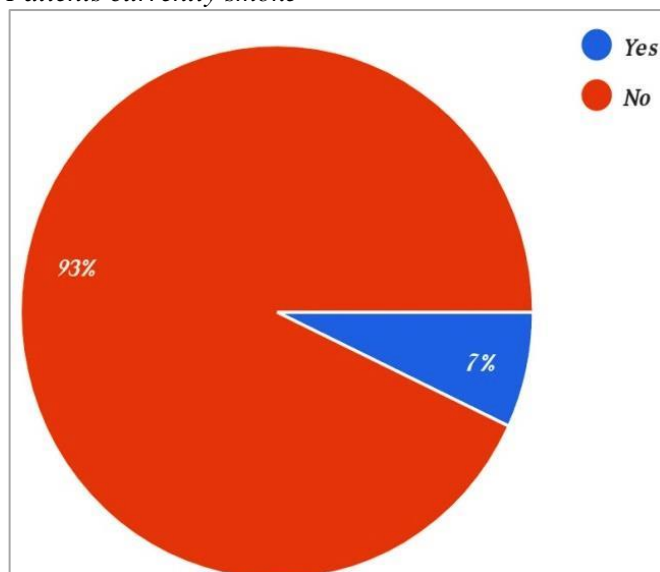
Figure 7
Patients who smoked in the past


Figure 8
Patients currently smoke

Hepatitis C and Liver Fibrosis
Our study used an extensive questionnaire to gather important information about the connection between liver fibrosis and Hepatitis C. Based on the collected replies, we determined that a noteworthy proportion of Hepatitis C patients had liver fibrosis, suggesting that the

viral infection had a significant effect on liver function.13% of patients were diagnosed with Hepatitis C with more than 5 to 10 years.

Figure 9
*Patients diagnosed with Hepatitis C*
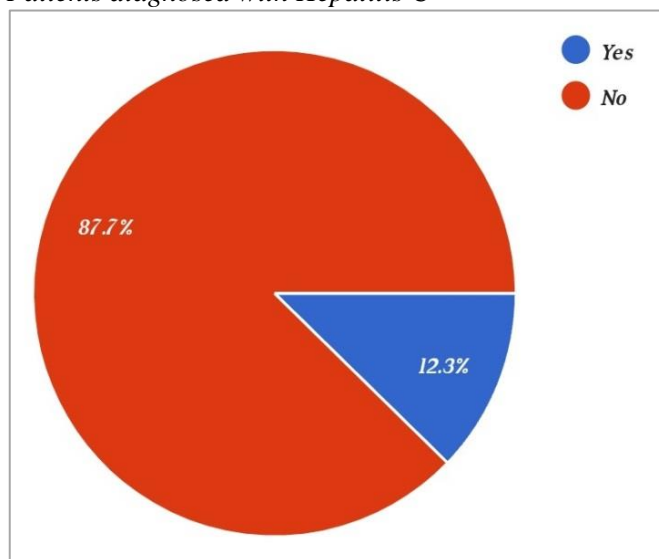
The development of focused interventions intended to reduce the incidence and severity of liver fibrosis in this population is guided by these findings, which add to a more thorough body of knowledge for medical professionals and legislators.

Liver Fibrosis Stages
Patients managing their liver health must be aware of the stages of liver fibrosis. Liver fibrosis is a condition in which the liver tissue gradually scars. It progresses through many stages, often classified from F0 to F4 by the METAVIR grading system. As the disease advances, patients may proceed through F0, which is the absence of fibrosis, to F1, which is mild fibrosis; F2, which is moderate fibrosis; F3, which is severe fibrosis; and finally F4, which is cirrhosis, which is characterized by significant scarring that impairs liver function.35% of patients were known about their fibrosis stage as shown in fig 10.

Figure 10
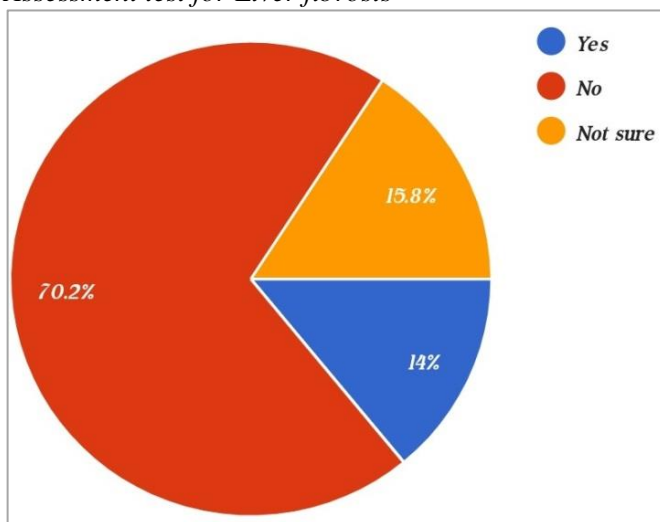*Patients Liver Fibrosis Stages*
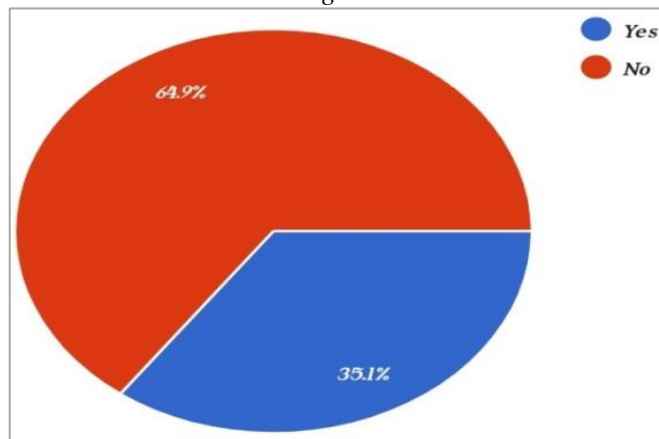
Liver Fibrosis Assessments

The respondents' experiences and comments provide insight into the frequency of diagnostic methods, which range from less intrusive methods like blood testing and elastography to more invasive techniques like liver biopsies. The questionnaire replies showed trends in patient preferences, acceptance, and accessibility of these evaluations. However, liver biopsy, which provides both direct sight and a histological assessment of liver tissue, continues to be the gold standard for determining the degree of fibrosis.

Figure 11

Assessment test for Liver fibrosis

Healthcare practitioners can customize diagnostic strategies for efficient monitoring and treating liver fibrosis in Hepatitis C patients by selecting tests based on patient preferences, cost, and availability.

DISCUSSION

Studies indicate that individuals who are co-infected with HIV and HCV progress through fibrosis more rapidly compared to those without co-infection, even when there is not a significant decline in CD4 cell count and after adjusting for factors like age, gender, and alcohol consumption. Liver fibrosis is commonly assessed using a grading system ranging from F0 (no fibrosis) to F4 (cirrhosis). Chronic viral infections, notably Hepatitis B and C, contribute to liver fibrosis. Considering environmental factors is essential in discussions about liver health because they can influence the occurrence and transmission of these diseases. Fibrosis can manifest gradually, and not all individuals with a long-standing HCV infection will advance to severe liver disease. Various factors, such as the duration of HCV infection, the genotype of the virus, individual host characteristics (including age and genetic predispositions), and concurrent liver conditions, contribute to the pace of fibrosis progression. Even individuals without advanced fibrosis but with persistent HCV infections are regularly monitored to assess liver

function and decide on the necessity of antiviral treatment. In the natural progression of liver fibrosis, liver damage tends to escalate over time, often leading to the onset of cirrhosis. Several factors, including genetic predisposition, viral infections such as Hepatitis B and C, metabolic issues, and lifestyle choices, can influence the dynamic process of liver fibrosis. Smoking, environmental factors, and socioeconomic status can significantly affect the rate of liver fibrosis progression. The research underscores the necessity for personalized healthcare approaches tailored to individual circumstances due to the variability in liver fibrosis advancement among Hepatitis C patients. This study sought to elucidate the natural progression of liver fibrosis in Hepatitis C patients by examining the interplay between viral factors and the impact of smoking, socioeconomic disparities, and environmental exposures on fibrosis development.

In Europe, approximately two-thirds of the burden of HCV disease is attributed to unsafe injection drug use. The objective of HCV therapy among People Who Inject Drugs (PWID) is not only to halt the progression of liver disease and its complications but also to prevent the onward transmission of the infection. Due to the significant prevalence of HCV infection among PWID, they represent a population of critical importance for intensified screening efforts and priority treatment access. In January 2016, Iceland initiated a nationwide program called TraP Hepatitis C (Treatment as Prevention) to treat all individuals with hepatitis C. This program ensured universal access to direct-acting antiviral treatment to treat the majority of HCV-positive individuals within two years of program commencement, with a particular focus on actively injecting PWID with recent HCV infection history. Over the initial three years, 95.3% of diagnosed HCV-positive patients were referred for therapy, and treatment was initiated in 96.5% of these cases. A sustained virological response (SVR) was achieved in 90.2% of treated patients. Consequently, the program resulted in an impressive 82% decrease in the prevalence of HCV RNA positivity among active PWID in Iceland (Beudeker et al., 2022).

More than 90% of cases of Hepatocellular Carcinoma (HCC) develop in the context of liver cirrhosis. Consequently, the immune pathogenesis of cirrhosis is closely intertwined with HCC's. There is a pressing need for novel, easily measurable biomarkers, such as peripheral immune markers, to identify early stages of HCC in liver cirrhosis, thereby improving disease outcomes and cure rates. Numerous studies have investigated the role of cytokines in predicting and detecting HCC due to their broad applicability and assessability with standard, scalable technology. However, these studies have examined a range of interleukins, chemokines, tissue-modulating, and growth

factors, with no consistent panel identified. One significant factor contributing to the limited reproducibility of identified markers among these studies is population heterogeneity. Indeed, most studies include diverse patient populations, encompassing individuals both with and without liver cirrhosis, varying BCLC scores, cancer stages, and, importantly, different underlying causes of HCC. This heterogeneity limits reproducibility and could affect clinical applicability. Although the clinically most established serological biomarker, AFP, exhibits limited diagnostic performance for early-stage HCC, combining it with age, gender, AFP-L3, and DCP (using the GALAD model) demonstrates promising diagnostic utility across various etiologies of HCC for detecting early-stage disease. However, data on the utility of GALAD or other protein markers in surveillance is currently lacking, including candidate protein markers like glypican-3, immune markers, miRNA, and epigenetic markers. In the future, further optimization of biomarker panels for early HCC will likely be reported. Future studies should investigate whether serum cytokines may provide additional predictive value in large prospective cohorts of early-stage HCC. This research aims to identify modifiable risk factors and offer guidance for targeted therapies to reduce liver fibrosis in vulnerable populations. The study delineates the stages of progression and offers a comprehensive overview of the natural course of hepatic fibrosis in Hepatitis C patients. Findings indicate a variable rate of fibrosis development, underscoring the importance of personalized patient care. Specifically concerning the natural progression of liver fibrosis in Hepatitis C patients, the study offers a nuanced understanding of the stages of advancement. The results underscore the importance of tailored patient management by revealing differing fibrosis progression rates. Additionally, in Hepatitis C patients, smoking exacerbates liver fibrosis by interacting with other risk factors. HCV infection and tobacco smoking are significant global public health concerns that present a range of health challenges. Moreover, they interact synergistically or additively to induce various serious illnesses. As an integral component of comprehensive care aimed at alleviating further strain on the liver, the study underscores the importance of smoking cessation programs. There exists a correlation between smoking and an elevated risk of liver disease development, particularly liver fibrosis. Due to its pro-inflammatory and oxidative stress-inducing effects, smoking can exacerbate liver damage when combined with liver conditions such as Hepatitis C. Cigarette smoke may exacerbate the inflammatory response in the liver of HCV patients, as it has been associated with increased levels of inflammatory cytokines. It is widely acknowledged that smoking induces oxidative stress and inflammation, both of which can worsen liver disease (Frankova et al., 2023).

This situation could worsen the progression of liver fibrosis in individuals with Hepatitis C. According to the statistical analysis, there was a positive correlation between smoking and the development of liver fibrosis in HCV patients. This correlation was strengthened when potential confounding variables such as age, gender, and alcohol intake were considered, enhancing our findings' robustness. Additionally, the study revealed a significant correlation between poverty among HCV patients and the development of liver fibrosis. Compared to patients with higher socioeconomic status, those with lower socioeconomic status exhibited a higher prevalence of advanced fibrosis. Statistical analysis further indicated a positive correlation between the stages of liver fibrosis and indicators of poverty. Lower socioeconomic status may present barriers to accessing healthcare, leading to delays in diagnosis and treatment initiation, which could exacerbate liver fibrosis progression. Our research highlights a strong association between the declining socioeconomic status of Hepatitis C patients and the development of liver fibrosis. Individuals with limited educational and financial opportunities were likelier to progress to advanced fibrosis stages (Juanola et al., 2021).

This study demonstrates that poor nutrition is often linked with poverty, which can exacerbate liver damage and impede the body's ability to heal itself. Poverty is commonly associated with other risk factors, such as higher rates of substance abuse, comorbidities, restricted access to a nutritious diet, and increasing prevalence of certain conditions, all of which may contribute to liver fibrosis. Additionally, the investigation suggests that environmental factors, including occupational exposure to chemicals or pollutants, may influence liver damage. Individuals with Hepatitis C may experience a faster progression of liver fibrosis when exposed to hepatotoxins. Substandard living conditions, including exposure to mold, moisture, or other environmental toxins, can exacerbate idiopathic liver disease. Stress resulting from inadequate living conditions can also adversely affect overall health. Liver fibrosis may be further aggravated by residing in areas with high pollution levels, where exposure to industrial waste, air pollution, and water pollution can introduce hepatotoxic chemicals to individuals. Certain occupations, such as manufacturing, mining, or agriculture, may expose workers to substances detrimental to liver health, as noted in this study. Additionally, diseases like diabetes and obesity, which are often influenced by environmental and lifestyle factors, can contribute to the development of liver fibrosis. NAFLD is closely linked with these issues and can progress to more severe liver complications (Barouki et al., 2023).

The study's findings suggest that environmental factors may impact access to healthcare resources, potentially leading to delays in diagnosis and treatment, allowing liver fibrosis to worsen unchecked. Public health campaigns can promote preventive measures by educating individuals about the impact of environmental factors on liver health. Preventing and managing liver fibrosis relies heavily on promoting healthy lifestyle choices, including maintaining a balanced diet, moderating alcohol intake, and quitting smoking. It is important to recognize that liver fibrosis in Hepatitis C is a complex condition influenced by various factors such as genetics, lifestyle choices, and viral load. Research studies often utilize questionnaires to gather data on patient demographics, lifestyle choices, and environmental exposures to identify potential correlations. Antiviral therapy, particularly Direct-Acting Antivirals (DAAs), can effectively slow down or even reverse fibrosis progression, underscoring the importance of early detection and access to advanced treatments in preventing severe liver damage and its consequences. Questionnaire results suggest varying levels of awareness and commitment to monitoring procedures, emphasizing the need for educational programs that stress the importance of regular liver health check-ups.

CONCLUSION

In conclusion, using a thorough questionnaire to examine the impact of smoking, environmental factors, and poverty on the natural history of liver fibrosis in Hepatitis C patients, our research has produced insightful findings. We found that in this sample, a lower socioeconomic position is associated with a faster progression of liver fibrosis, highlighting the need for focused measures to alleviate healthcare inequities. Environmental factors, such as living circumstances and workplace dangers, significantly influence the degree of liver fibrosis. Furthermore, our research demonstrated the deleterious effects of smoking on liver health in individuals with Hepatitis C, highlighting the significance of smoking cessation programs. For complete patient treatment and better outcomes in this vulnerable population, measures must be implemented to address socioeconomic gaps, reduce environmental dangers, and encourage lifestyle adjustments. Anti-fibrotic therapy, such as biological, pharmaceutical, nutritional, and behavioral changes, is required to prevent the potentially fatal stage of advanced liver fibrosis and cirrhosis. Preventing oxidative stress, hepatocyte cell death, and liver inflammation's primary causes is the current treatment approach for liver fibrosis. The only treatment available for advanced liver cancer and cirrhosis is liver transplantation. To enhance treatment efficacy and deliver medications precisely, The research emphasizes the cumulative effects of smoking, highlighting the necessity of all-encompassing care. The questionnaire results draw attention to socioeconomic hurdles, such as restricted access to healthcare, which postpone diagnosis and treatment initiation. This highlights how crucial it is to address socioeconomic determinants of health when managing Hepatitis C. The results emphasize the significance of comprehensive approaches that integrate antiviral therapy, financial assistance, and lifestyle adjustments to enhance the quality of life for those suffering from liver fibrosis caused by Hepatitis C. Nano-delivery devices have been used. Although no proven methods exist for treating liver fibrosis, pre-clinical and clinical trials are necessary before developing novel therapies. Although no proven methods exist for treating liver fibrosis, pre-clinical and clinical trials are necessary before developing novel therapies. Proteomic staining techniques, imaging techniques, serum biomarkers, and fibrosis scoring systems can be used to assess the effectiveness of a treatment. Creating organoid models for liver fibrosis produced from patients may potentially progress the discovery of future anti-fibrotic drugs. Furthermore, novel delivery technologies can achieve more effective therapies and fewer side effects from therapy. Looking ahead, more creative and focused therapies to address the identified risk factors should be investigated in future studies on liver fibrosis in Hepatitis C patients. By combining cutting-edge technology with non-invasive diagnostic techniques, liver fibrosis evaluation can be made more accessible and patient-friendly. Prospective research should also concentrate on the long-term effects of smoking, environmental exposures, and socioeconomic differences on the development of liver fibrosis, as this will help shape individualized treatment regimens. In order to adopt preventative measures, increase public awareness, and push for social changes that lessen the socioeconomic factors affecting liver health, cooperation between researchers, legislators, and healthcare professionals is crucial. Future research can further our understanding of liver fibrosis in Hepatitis C patients and open the door to better patient outcomes and public health initiatives by adopting a holistic approach that considers social and environmental factors in addition to medical ones. The research indicates that patients had differing degrees of awareness and compliance with monitoring protocols, underscoring the necessity for improved education regarding the significance of routine examinations.

REFERENCES

Barouki, R., Samson, M., Blanc, E. B., Colombo, M., Zucman-Rossi, J., Lazaridis, K. N., Miller, G. W., & Coumoul, X. (2023). The exposome and liver disease - how environmental factors affect liver health. *Journal of Hepatology*, *79*(2), 492-505. https://doi.org/10.1016/j.jhep.2023.02.034

Beudeker, B. J., Groothuismink, Z. M., Eijk, A. A., Debes, J. D., & Boonstra, A. (2022). Circulating cytokines reflect the etiology-specific immune environment in cirrhosis and HCC. https://doi.org/10.21203/rs.3.rs-1685714/v1

Chan, H. L., Wong, G. L., Wong, V. W., Wong, M., Chan, C. Y., & Singh, S. (2021). Questionnaire survey on knowledge, attitudes, and behaviour towards viral hepatitis among the Hong Kong public. *Hong Kong Medical Journal*. https://doi.org/10.12809/hkmj219463

Frankova, S., Uzlova, N., Merta, D., Pitova, V., & Sperl, J. (2023). Predictors of significant liver fibrosis in people with chronic hepatitis C who inject drugs in the Czech Republic. *Life*, *13*(4), 932. https://doi.org/10.3390/life13040932

Ho, Y. Y., Lagares, D., Tager, A. M., & Kapoor, M. (2014). Fibrosis—a lethal component of systemic sclerosis. *Nature Reviews Rheumatology*, *10*(7), 390-402. https://doi.org/10.1038/nrrheum.2014.53

Jamalinia, M., Lonardo, A., & Weiskirchen, R. (2024). Sex and gender differences in liver fibrosis: Pathomechanisms and clinical outcomes. *Fibrosis*, *2*(1), 10006-10006. https://doi.org/10.70322/fibrosis.2024.10006

Juanola, O., Martínez-López, S., Francés, R., & Gómez-Hurtado, I. (2021). Non-alcoholic fatty liver disease: Metabolic, genetic, epigenetic and environmental risk factors. *International Journal of Environmental Research and Public Health*, *18*(10), 5227. https://doi.org/10.3390/ijerph18105227

Ortiz, C., Schierwagen, R., Schaefer, L., Klein, S., Trepat, X., & Trebicka, J. (2021). Extracellular matrix remodeling in chronic liver disease. *Current Tissue Microenvironment Reports*, *2*(3), 41-52. https://doi.org/10.1007/s43152-021-00030-3

Sanyal, A. J. (2019). Past, present and future perspectives in nonalcoholic fatty liver disease. *Nature Reviews Gastroenterology & Hepatology*, *16*(6), 377-386. https://doi.org/10.1038/s41575-019-0144-8

Sears, M. E., & Genuis, S. J. (2012). Environmental determinants of chronic disease and medical approaches: Recognition, avoidance, supportive therapy, and detoxification. *Journal of Environmental and Public Health*, *2012*, 1-15. https://doi.org/10.1155/2012/356798

Singh, S., Pal, N., Shubham, S., Sarma, D. K., Verma, V., Marotta, F., & Kumar, M. (2023). Polycystic ovary syndrome: Etiology, current management, and future therapeutics. *Journal of Clinical Medicine*, *12*(4), 1454. https://doi.org/10.3390/jcm12041454

Talens, M., Tumas, N., Lazarus, J. V., Benach, J., & Pericàs, J. M. (2021). What do we know about inequalities in NAFLD distribution and outcomes? A scoping review. *Journal of Clinical Medicine*, *10*(21), 5019. https://doi.org/10.3390/jcm10215019

Xiao, J., Wang, F., Wong, N., Lv, Y., Liu, Y., Zhong, J., Chen, S., Li, W., Koike, K., Liu, X., & Wang, H. (2020). Epidemiological realities of alcoholic liver disease: Global burden, research trends, and therapeutic promise. *Gene Expression*, *20*(2), 105-118. https://doi.org/10.3727/105221620x15952664091823

Youngstrom, E. A., Choukas-Bradley, S., Calhoun, C. D., & Jensen-Doss, A. (2015). Clinical guide to the evidence-based assessment approach to diagnosis and treatment. *Cognitive and Behavioral Practice*, *22*(1), 20-35. https://doi.org/10.1016/j.cbpra.2013.12.005

Zein, C. O., Unalp, A., Colvin, R., Liu, Y., & McCullough, A. J. (2011). Smoking and severity of hepatic fibrosis in nonalcoholic fatty liver disease. *Journal of Hepatology*, *54*(4), 753-759. https://doi.org/10.1016/j.jhep.2010.07.040