Original Article

Seropositivity and coinfection of hepatitis B and hepatitis C viruses in Central India: A hospital-based study

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Abstract

Background: Hepatitis B virus (HBV) and Hepatitis C virus (HCV) show similarity in the transmission, distribution, hepatotropism, and leading to chronic asymptomatic infection. Coinfection of HBV and HCV can lead to more severe liver disease and an increased risk for progression to hepatocellular carcinoma (HCC). Most of the people with chronic infection are unaware of their HBV and HCV infections, hence facilitating these to go undiagnosed until these viruses have caused serious liver damage and they act as a potential source of infection for the community at large. Therefore, the present study aimed to find the prevalence of HBV and HCV along with incidences of coinfection of HBV and HCV in patients seeking hospital care in central India. **Methods:** A five-year hospital-based study was carried out at the tertiary care hospital in Central India from 2018 to 2022. A total of 72402 patients attending the outdoor patients and admitted indoor patients who were advised for HBV and HCV for screening before any invasive/surgical procedure and patients who presented with symptoms of acute or chronic liver disease were included in this study. Screening was done by immunochromatography-based card test followed by the confirmation of all samples by enzyme immunoassay. **Results:** Seroprevalence of HBV and HCV was found to be 3.71% and 1.91%, respectively. Coinfection with HBV/HCV was seen in 0.13% of the individuals. The overall prevalence of HBV, HCV, and HBV-HCV coinfection was significantly higher in the male population as compared to females. **Conclusion:** The study findings of seroprevalence of HBV and HCV among the hospital-based population will help to get a baseline understanding of the disease burden in central India. The HBV/HCV coinfection rate also raises serious concerns owing to its high prevalence rate among the younger age.

Keywords: Coinfection, HBV, HCV, seroprevalence

Introduction

Hepatitis B virus (HBV) and hepatitis C virus (HCV) infections are significant global public health concerns, primarily transmitted through the parenteral route and leading to a substantial burden of acute and chronic liver disease (CLD) with associated morbidity and mortality.[1-3] Globally, an estimated 400 million individuals live with chronic HBV or HCV, with 1.5 million new infections added annually.[4] In 2019 alone, HBV and HCV resulted in approximately 1.1 million deaths, primarily from complications like cirrhosis and hepatocellular carcinoma (HCC).[4,5] Worryingly, around 500 million people globally remain unaware of their HBV or HCV infection, facilitating silent progression until significant liver damage occurs.[6]

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Both HBV and HCV are hepatotropic viruses, exhibiting similarities in transmission, tissue distribution, and their propensity to establish chronic asymptomatic infections. These infections can ultimately lead to liver fibrosis, cirrhosis, and HCC.[7-9] Coinfection with HBV and HCV is not uncommon in areas with high endemicity. Coinfected individuals experience a more severe disease course, with a heightened risk of liver cirrhosis, hepatic decompensation, and HCC development.[10]

India faces a burden of endemic HBV and HCV infections, with reported prevalence estimates ranging from 3%–4% for HBV and 1.8%–2.5% for HCV.[11-13] However, the lack of a robust national viral hepatitis surveillance system hinders the acquisition of precise nationwide prevalence data. Existing reports primarily rely on isolated research studies or data from blood banks.[14-16] Furthermore, prevalence studies specifically targeting the general population in India remain limited, highlighting a critical gap in knowledge necessary for effective prevention and control strategies.[17]

This present study adopts a retrospective approach to assess the prevalence of HBV and HCV infections, along with the incidence of coinfection, among patients seeking hospital care in central India. The findings from this study will contribute valuable data to update national estimates on HBV and HCV prevalence, thereby informing public health initiatives.

Materials and Methods

Study design and participants

This five-year retrospective study was conducted at a tertiary care hospital in Central India from January 2018 to December 2022, with approval from the Institutional Ethics Committee. The study included patients who underwent HBV and HCV screening before invasive/surgical procedures or presented with symptoms suggestive of acute or chronic liver disease. These patients were recruited from both outpatient and inpatient departments.

Data and specimen collection

Epidemiological data encompassing demographics (age, gender, occupation), clinical details, department/ward information, and potential risk factors were collected from patients during blood sample collection. Blood samples were obtained from all age groups and genders. Exclusion criteria included hemolyzed specimens, samples with incomplete data, and insufficient sample volume. Approximately 5 mL of venous blood was collected in plain vials and transported to the laboratory for analysis.

Screening test

Following blood collection, samples were allowed to clot at room temperature before serum separation via centrifugation. An initial screening for HBV and HCV infections was performed using commercially available rapid diagnostic tests (RDTs) based on immunochromatography. HBV screening targeted the detection of Hepatitis B surface antigen (HBsAg), while HCV screening focused on identifying IgM antibodies to HCV. Assays were conducted following the manufacturer's instructions. Results were interpreted based on the specific kit's guidelines, with a negative result indicated by the presence of only the control line and the absence of a test line. A positive result was confirmed by the simultaneous appearance of both control and test lines.

Confirmatory test

Samples demonstrating reactive results on the RDTs underwent further confirmatory testing using commercially available enzyme-linked immunosorbent assay (ELISA) kits for HBV and HCV. Serum analysis for HBV surface antigen employed either SD HBsAg ELISA (S. D. Bio Standard Diagnostics, Gurugram, India) or Q-LISA HBsAg ELISA (Q-Line Biotech Pvt. Ltd, New Delhi, India) kits. Detection of anti-HCV total antibodies utilized either Erba-Lisa HCV Gen3 (v2) anti-HCV ELISA (ERBA diagnostics Mannheim GmbH, Germany) or Q-LISA HCV ELISA kits (Q-Line Biotech Pvt. Ltd, New Delhi, India). All tests were performed adhering to the manufacturer's protocols, and results were interpreted according to the respective kit instructions. Both ELISA kits reportedly possess high sensitivity (100%) and specificity (99%) according to the manufacturers' data.

Statistical analysis

The prevalence of HBV and HCV infection was expressed as percentages. Statistical analysis of the study findings for HBV and HCV employed the Chi-square test ($\chi 2$) with Yates' correction. A *P* value less than 0.05 was considered statistically significant.

Results

The study investigated the prevalence of HBV and HCV infection in a central Indian hospital during 2018–2022. A total of 72402 clinical samples were tested for HBV and HCV infection. The overall prevalence of HBV or HCV infection was 5.43%, with HBV being slightly more prevalent (3.71%) than HCV (1.91%). Coinfection with both HBV and HCV was found in 0.13% of the samples. The prevalence of all three conditions (HBV, HCV, and coinfection) was significantly higher in males compared to females [Table 1].

The yearly prevalence of HBsAg ranged between 3.13% and 5.30%, with a mean of 3.87%. The yearly prevalence of anti-HCV ranged between 1.28% and 2.77%, with a mean of 2.12%. There was a potential decrease in the prevalence of both HBsAg and anti-HCV over the five-year study period, possibly due to the effect of the SARS-CoV-2 pandemic on healthcare service utilization. A potential decrease in testing rates for both markers was observed in 2020 and 2021. This likely coincides with the peak of the SARS-CoV-2 pandemic, when healthcare resources were heavily focused on managing suspected COVID-19 cases [Table 2, Figure 1].

Table 1: Gender wise distribution of HBV and HCV cases

Infection	Total cases *n* (%)			Positive cases *n* (%)			χ^2 with 1 degree of freedom	*P* value
	Male	Female	Total	Male	Female	Total		
HBV	44890 (62)	27512 (38)	72402	1930 (71.8)	758 (28.2)	2688 (3.71)	347.1316	<0.0001
HCV	40496 (61.98)	24846 (38.02)	65342	991 (79.5)	255 (20.5)	1246 (1.91)	300.2937	<0.0001
Coinfection				77 (86.5)	12 (13.5)	89 (0.13)	32.107	<0.0001

Table 2: Year-wise distribution of HBV, HCV, and HBV/HCV coinfection cases

Year	2018	2019	2020	2021	2022	Total
Total no of cases	20101	20863	9753	9296 (HBV) 2236 (HCV)	12389	72402
HBV positive (%)	684 (3.4)	680 (3.26)	305 (3.13)	495 (5.3)	524 (4.23)	2688 (3.71)
HCV positive (%)	257 (1.28)	445 (2.13)	251 (2.57)	62 (2.77)	231 (1.86)	1246 (1.91)
Coinfection (%)	28 (0.14)	28 (0.13)	14 (0.14)	5 (0.22)	14 (0.11)	89 (0.13)

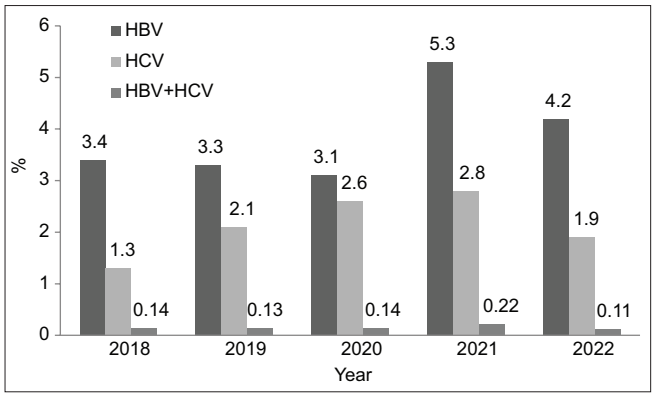

Figure 1: Year-wise prevalence of HBV, HCV, and HBV/HCV infections

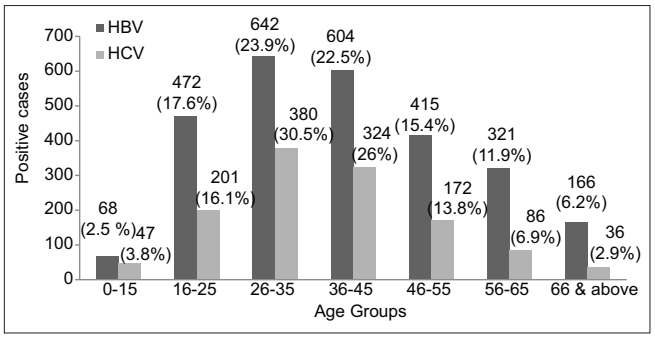

Figure 2: HBV and HCV positivity in various age groups

Analysis of age groups revealed a clear pattern for both HBV and HCV infection. The highest prevalence was concentrated in younger adults, specifically those between 26 and 35 years old. This age range accounted for 23.9% (HBV) and 30.5% (HCV) of positive tests, followed closely by the 16–25-year-old group. Conversely, infection rates were significantly lower in both children under 16 and adults over 66 years old. This trend suggests a possible link between age and risk factors associated with HBV and HCV transmission [Figure 2].

This study identified a clear association between age and HBV prevalence. The highest infection rates were found in younger adults, particularly those between 26 and 35 years old (23.9% positive). This age group had an average age of 30.86 years. Prevalence remained relatively high in the 16–25-year-old group (17.6% positive, average age 21.74 years). Conversely, HBV infection rates were significantly lower in children under 16 (2.5% positive, average age 11.39 years) and adults over 66 (6.2% positive, average age 73.23 years). The widespread childhood hepatitis B vaccination program implemented in India around 2011–2012 likely explains the lower prevalence observed in younger children. However, the presence of some positive cases in this age group suggests the possibility of vertical transmission, where the infection is passed from mother to child during birth.

Similar to HBV, this study revealed a strong correlation between age and HCV infection. The highest prevalence was observed in younger adults, with the 26–35-year-old age group showing the highest infection rate (30.5%, average age 31.04 years). The 36–45-year-old group also had a significant prevalence (26.0%, average age 40.7 years). Infection rates declined steadily in older age groups, with the lowest prevalence found in adults over 66 (2.9%, average age 74.55 years). This pattern aligns with the findings for HBV, suggesting a potential link between age and behaviors associated with HCV transmission. The presence of a small number of positive cases in children under 16 (3.8%, average age 9.17 years) might be due to vertical transmission from mother to child.

The study also investigated HBV and HCV prevalence among patients admitted to different hospital wards. Samples from antiretroviral therapy (ART), general medicine, and gastroenterology wards showed a significantly higher prevalence of both infections compared to other wards. This finding suggests that individuals admitted to these specific departments might be at an increased risk of contracting HBV or HCV. Further investigation is needed to understand the reasons behind this association [Table 3].

Discussion

This study investigated the prevalence of Hepatitis B (HBV) and Hepatitis C (HCV) infections in a central Indian hospital. The

Table 3: Department-wise prevalence of HBV, HCV, and coinfection

Departments	HBV positive	HCV positive	HBV & HCV positive	Total positive (%)
General medicine	646	185	18	831 (21.12)
Gastroenterology	531	124	8	655 (16.65)
ART (Anti-retroviral therapy)	495	770	51	1265 (32.15)
General surgery	256	37	-	293 (7.45)
Neurology	216	48	3	264 (6.71)
Orthopedics	149	12	3	161 (4.09)
Otolaryngology	147	6	3	153 (3.89)
Pulmonary	82	58	3	140 (3.56)
Cardiology	79	3	-	82 (2.08)
Nephrology	30	3	-	33 (0.84)
Pediatrics	23	-	-	23 (0.58)
Radiotherapy	22	-	-	22 (0.56)
Other departments	12	-	-	12 (0.3)
Total	2688	1246	89	3934 (100)

overall prevalence of HBV (3.71%) aligns with previous studies conducted in India, ranging from 3.5% to 4.97% (Barabanki, Jodhpur, Erode).[6,18,19] However, significant geographical variation exists. Some regions report higher prevalence (up to 9.3%),[20-22] while others show lower rates (1.5% to 2.92%).[3,23-25] Globally, HBV endemicity is categorized as high (≥8%), intermediate (2-7%), or low (<2%). With its 2–4.7% HBsAg positivity rate, India falls within the intermediate endemicity zone.[26,27] This study's findings further support this classification.

Our study found a 1.91% prevalence of anti-HCV antibodies, which aligns with a subset of prior research conducted in India reporting prevalence between 1.76% and 2.3%.[3,6,28] As observed with HBsAg, anti-HCV prevalence exhibited significant geographical variations across the country.[29-32] This finding underscores the need for further investigation into the underlying factors contributing to these disparities. Encouragingly, the global anti-HCV prevalence has decreased from 2% to 0.7% in recent years,[33,34] highlighting the potential effectiveness of control strategies.

Chronic HBV and HCV infections pose a significant global health threat. A substantial proportion of infected individuals remain undiagnosed, potentially progressing to serious liver complications like cirrhosis and hepatocellular carcinoma.[35,36] These complications contribute significantly to the burden of liver disease, particularly in Low- and Middle-Income Countries (LMICs).[37,38] Fortunately, advancements like direct-acting antivirals for HCV and childhood HBV vaccination offer promising avenues for eradication. The World Health Organization's targets for 2030 aim for a 65% reduction in hepatitis mortality and a 90% reduction in new infections globally.[39]

Early identification of undiagnosed cases is essential for prompt management and treatment of chronic HBV and HCV infections. Accurate data on prevalence are crucial for monitoring progress toward global elimination goals set by the World Health Organization.[39-41] In recognition of this need, India established the National Viral Hepatitis Control Programme (NVHCP) in 2018, aiming to achieve eradication by 2030.[42] Strengthening such programs alongside efficient screening strategies will be instrumental in achieving these ambitious global targets.

The COVID-19 pandemic unfortunately hampered these efforts. Disruptions to healthcare services due to lockdowns, travel restrictions, and resource allocation toward COVID-19 diagnosis resulted in a significant decrease in samples received for HBV and HCV testing (approximately 45% fewer in 2020–2021 compared to the previous year). This aligns with observations from other studies.[43-45] This highlights the importance of building resilient healthcare systems prepared to address both ongoing and emerging public health challenges.

This retrospective study has inherent limitations. This study's retrospective design limited access to comprehensive sociodemographic data and clinical laboratory findings for HBV and HCV-positive cases. Furthermore, the study population represents individuals who sought treatment at the hospital, potentially limiting generalizability to the broader Central Indian community. Future research incorporating prospective data collection methods and a population-based sampling approach would be valuable in gaining a more comprehensive understanding of the epidemiology of HBV and HCV infections in this region.

Conclusion

This study provides valuable baseline data on the seroprevalence of HBV and HCV infections among a hospital-based population in central India. The observed prevalence rates highlight the significant disease burden in this region. The concerning coinfection rate, particularly among younger individuals, underscores the need for focused interventions. Public health strategies promoting awareness and accessibility of screening programs are crucial to prevent transmission and improve patient prognosis.

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Conflicts of interest

There are no conflicts of interest.

References

1. El-Serag HB. Epidemiology of viral hepatitis and hepatocellular carcinoma. Gastroenterology 2012;142:1264–73.
2. Eke AC, Eke UA, Okafor CJ. Prevalence correlates and pattern of hepatitis B surface antigen in a low resource setting. Virol J 2011;8:12.
3. Mittal G, Gupta P, Gupta R, Ahuja V, Mittal M, Dhar M. Seroprevalence and risk factors of hepatitis B and hepatitis C virus infections in Uttarakhand, India. J Clin Exp Hepatol 2013;3:296-300.
4. Hepatitis B. Available from: https://www.who.int/news-room/factsheets/detail/hepatitis-b[Last accessed on 2024 Feb 05].
5. Hepatitis C. Available from: https://www.who.int/news-room/fact-sheets/detail/hepatitis-c. [Last accessed on 2024 Feb 05]
6. Agarwal L, Singh AK, Agarwal A, Singh RP. Incidental detection of hepatitis B and C viruses and their coinfection in a hospital-based general population in tertiary care hospital of Uttar Pradesh. J Family Med Prim Care 2018;7:157-61.
7. Karoney MJ, Siika AM. Hepatitis C virus (HCV) infection in Africa: A review. Pan Afr Med J 2013;14:44.
8. Bane A, Patil A, Khatib M. Healthcare cost and access to care for viral hepatitis in Ethiopia. Int J Innov Appl Stud 2014;9:1718–23.
9. Shi J, Zhu L, Liu S, Xie WF. A meta-analysis of case–control studies on the combined effect of hepatitis B and C virus infections in causing hepatocellular carcinoma in China. Br J Cancer 2005;92:607–12.
10. Konstantinou D, Deutsch M. The spectrum of HBV/HCV coinfection: Epidemiology, clinical characteristics, viral interactions and management. Ann Gastroenterol 2015;28:221–8.
11. Grewal US, Walia G, Bakshi R, Chopra S. Hepatitis B and C viruses, their coinfection and correlations in chronic liver disease patients: A tertiary care hospital study. Int J Appl Basic Med Res 2018;8:204-9.
12. Chowdhary A. Epidemiology of hepatitis B virus infection in India. Hepat B Annu 2004;1:17–24.
13. Chandra M, Khaja MN, Farees N, Poduri CD, Hussain MM, Aejaz Habeeb M, *et al.* Prevalence, risk factors and genotype distribution of HCV and HBV infection in the tribal population: A community based study in South India. Trop Gastroenterol 2003;24:193–5.
14. Arora D, Arora B, Khetarpal A. Seroprevalence of HIV, HBV, HCV and syphilis in blood donors in Southern Haryana. Indian J Pathol Microbiol 2010;53:308-9.
15. Ali S, Shukla I, Malik A, Rizvi M, Ajmal MR. Prevalence of HCV and HBV infection in liver disorders in the Aligarh region of western Uttar Pradesh. Indian. J Pathol Microbiol 2008;51:460-1.
16. Mysorekar VV, Rao SG, Mahadeva KC. Liver histology in patients on hemodialysis with chronic hepatitis C viral infection. Indian J Pathol Microbiol 2008;51:182-5.
17. Narayanasamy K, Annasamy C, Ramalingam S, Elumalai S. Study of Hepatitis B and C virus infection in urban and rural population of Tamil Nadu, India. Int J Curr Microbiol App Sci 2015;4:443-51.
18. Khullar S, Parihar RS, Khatri PK, Maurya VK. Seroprevalence of hepatitis B virus and hepatitis C virus infection in haemodialysis patients at tertiary care hospital in Western Rajasthan, India. J Acad Clin Microbiol 2020;22:23-7.
19. Lavanya V, Viswanathan T, Arul Sheeba Malar S, Malarvizhi A, Moorthy K. Prevalence of hepatitis B virus infection among blood donors with antibodies to hepatitis B core antigen. Int J Med Med Sci 2012;4:128-37.
20. Khan S, Madan M, Virmani SK. Prevalence of Hepatitis B virus, genotypes, and mutants in HBsAg-positive patients in Meerut, India. Iran Biomed J 2019;23:354-61.
21. Khan MA, Zargar SA, Upadhyay J, Lone TA, Aggarwal R, Bashir G, *et al.* Epidemiology of hepatitis B and C viral infections in Ladakh region. Indian J Gastroenterol 2018;37:504-10.
22. Chandra N, Joshi N, Raju YS, Kumar A, Teja VD. Hepatitis B and/or C co-infection in HIV infected patients: A study in a tertiary care centre from South India. Indian J Med Res 2013;138:950-4.
23. Juttada U, Smina TP, Kumpatla S, Viswanathan V. Seroprevalence and risk factors associated with HBV and HCV infection among subjects with type 2 diabetes from South India. Diabetes Res Clin Pract 2019;153:133-7.
24. Mishra K, Shah A, Patel K, Ghosh K, Bharadva S. Seroprevalence of HBV, HCV and HIV-1 and correlation with molecular markers among multi-transfused thalassemia patients in Western India. Mediterr J Hematol Infect Dis 2020;12:e2020038.
25. Shanmugam RP, Balakrishnan S, Varadhan H, Shanmugam V. Prevalence of hepatitis B and hepatitis C infection from a population-based study in Southern India. Eur J Gastroenterol Hepatol 2018;30:1344-51.
26. Rahaman J, Sengupta M, Barik G, Sarkar S, Sarkar R, Sengupta M. Seroprevalence and co-infection of hepatitis B and hepatitis C among patients in a tertiary care hospital in Eastern India. J Assoc Physicians India 2019;67:27-9.
27. Lavanchy D. Hepatitis B virus epidemiology, disease burden, treatment, and current and emerging prevention and control measures: A review. J Viral Hepat 2004;11:97-107.
28. Patil SR, Datkhile KD, Ghorpade MV, Patil SS, Kakade SV. Seroprevalence, risk factors and genotype distribution for Hepatitis C infection: A study from rural hospital in Maharashtra. Indian J Med Microbiol 2017;35:563-7.
29. Trickey A, Sood A, Midha V, Thompson W, Vellozzi C, Shadaker S, *et al.* Clustering of hepatitis C virus antibody positivity within households and communities in Punjab, India. Epidemiol Infect 2019;147:e283.

30. Puri P, Srivastava S. Lower chronic hepatitis B in South Asia despite all odds: Bucking the trend of other infectious diseases. Trop Gastroenterol 2012;33:89–94.
31. Nikitha S, Sabeena S, Robin S, Hiren D, Prasad V, Aswathyraj S, *et al.* The prevalence of anti-hepatitis C antibody among acute febrile illness cases in Idar Taluk, Gujarat, West India. Indian J Med Microbiol 2019;37:225-9.
32. Medhi S, Goswami B, Das AK, Singh TB, Husain SA, Sehgal A, *et al.* New insights into hepatitis C virus infection in the tribal-dominant part of Northeast India. Arch Virol 2012;157:2083-93.
33. Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. Lancet Infect Dis 2005;5:558–67.
34. Polaris Observatory HCV Collaborators. Global change in hepatitis C virus prevalence and cascade of care between 2015 and 2020: A modelling study. Lancet Gastroenterol Hepatol 2022;7:396-415.
35. Ott JJ, Stevens GA, Groeger J. Global hepatitis report 2017. World Health Organisation; 2017.
36. Peeling RW, Boeras DI, Marinucci F, Easterbrook P. The future of viral hepatitis testing: Innovations in testing technologies and approaches. BMC Infect Dis 2017;17(Suppl 1):699.
37. Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: A systematic review of data published between 1965 and 2013. Lancet 2015;386:1546–55.
38. WHO Global Action Strategy. Prevention and Control of Viral Hepatitis Infection. Available from: https://www.paho.org/en/file/32284/download?token=ckCQObFV. Updated on 2021. [Last accessed on 2022 Sep 19].
39. Available from: https://www.who.int/health-topics/hepatitis/elimination-of-hepatitis-by-2030#tab=tab_1. [Last accessed on 2024 Feb 05].
40. Lemoine M, Nayagam S, Thursz M. Viral hepatitis in resource-limited countries and access to antiviral therapies: Current and future challenges. Future Virol 2013;8:371-80.
41. Kishanrao S. Viral hepatitis in India. Arch Hept Res 2020;6:3-6.
42. Launch of National Viral Hepatitis Control Program. Available from: https://nvhcp.mohfw.gov.in/Launch-of-National-Viral-Hepatitis-Control-Program. [Last accessed on 2024 Feb 05].
43. Gupta N, Desalegn H, Ocama P, Lacombe K, Njouom R, Afihene M, *et al.* Converging pandemics: Implications of COVID-19 for the viral hepatitis response in sub-Saharan Africa. Lancet Gastroenterol Hepatol 2020;5:634-6.
44. Ismail Z, Aborode AT, Oyeyemi AA, Khan H, Hasan MM, Saha A, *et al.* Impact of COVID-19 pandemic on viral hepatitis in Africa: Challenges and way forward. Int J Health Plann Manage 2022;37:547-52.
45. Roopa C, Kamineni S, Shilpa PN, Rao BR. Prevalence of Hepatitis B and Hepatitis C infections in a tertiary care hospital, Telangana, India – Comparison of pre-pandemic and COVID-19 pandemic times. J Pure Appl Microbiol 2022;16:2521-9.