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Epidemiology of Viral Hepatitis in Saudi Arabia: A Systematic Review

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Abstract

Introduction: Viral hepatitis remains a significant public health challenge in Saudi Arabia, with hepatitis B (HBV) and hepatitis C (HCV) posing major concerns. Despite various interventions, the prevalence of these infections continues to impact the population. This systematic review aimed to assess the epidemiology of viral hepatitis in Saudi Arabia, focusing on the effectiveness of interventional studies and clinical trials conducted in the last 25 years. It sought to synthesize data on the prevalence, distribution, and impact of HBV and HCV, highlighting the effectiveness of various interventions.

Methods: A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, and the Cochrane Library, focusing on interventional studies and observational cohorts. Inclusion criteria targeted studies on HBV and HCV interventions, such as vaccination programs, public health initiatives, and antiviral treatment trials within Saudi Arabia. Exclusion criteria removed observational studies, reviews, and non-interventional research. Data extraction focused on study design, interventions, and outcomes.

Results: Eleven studies met the inclusion criteria, demonstrating a range of interventions from vaccination programs and public health campaigns to antiviral treatments. Vaccination programs reported uptake rates exceeding 90%, with HBV prevalence decreasing from 7% to below 1% in vaccinated cohorts (Risk Ratio [RR]: 0.14, 95% CI: 0.05-0.40). Antiviral treatment trials for HCV showed SVR rates above 90%, significantly reducing viral load and risk of chronic liver disease. Public health campaigns improved hepatitis knowledge and behaviors modestly, with a 25% increase in knowledge scores (RR: 0.82, 95% CI: 0.69-0.97).

Conclusions: This systematic review highlights the significant impact of vaccination programs, antiviral treatments, and educational campaigns on the epidemiology of viral hepatitis in Saudi Arabia. The findings underscore the effectiveness of comprehensive strategies in reducing the prevalence and incidence of HBV and HCV, demonstrating the critical role of multifaceted interventions in public health efforts against viral hepatitis. These insights are pivotal for informing future policies and healthcare strategies aimed at mitigating the burden of viral hepatitis within the Saudi population.

Keywords: Viral Hepatitis, Saudi Arabia, Vaccination, Antiviral Treatment, Public Health Campaigns.

Introduction

The landscape of viral hepatitis in Saudi Arabia presents a complex public health challenge, characterized by the prevalence of hepatitis B (HBV) and hepatitis C (HCV) viruses among the population. Hepatitis B is notably endemic in the region, with a reported carrier rate of approximately 1.3% among the general population, reflecting a significant public health concern [1]. Meanwhile, hepatitis C also contributes to the disease burden, with prevalence estimates suggesting around 0.4% of the Saudi population is affected [2]. These figures underscore the ongoing struggle with viral hepatitis, necessitating targeted public health strategies and interventions to mitigate the spread and impact of these infections.

Contributing to the epidemiological complexity is the variation in HBV and HCV prevalence across different demographic and geographic segments within the country. Studies have shown that HBV infection rates are higher in certain regions, particularly in the southwestern parts of Saudi Arabia, where the prevalence can reach up to 6.7% [3]. This geographical variability is mirrored in the distribution of HCV, with some areas reporting prevalence rates significantly above the national average [4]. The disparate distribution of these viruses highlights the importance of region-specific data in informing public health policies and interventions. The transmission dynamics of viral hepatitis in Saudi Arabia further compound the public health challenge. For HBV, vertical transmission from mother to child and horizontal transmission during early childhood remain significant modes of transmission [5]. For HCV, on the other hand, unsafe medical practices, including the use of unsterilized medical equipment and blood transfusions before the implementation of rigorous screening protocols, have historically been major contributors to the spread of the virus [6]. Despite improvements in healthcare practices and the implementation of the national screening programs, these transmission pathways contribute to the persistence of several viral hepatitis as a public health issue. The socioeconomic impact of viral hepatitis in Saudi Arabia is profound, with both HBV and HCV leading to chronic liver disease, cirrhosis, and hepatocellular carcinoma (HCC). The economic burden associated with the management of chronic hepatitis, liver failure, and liver cancer places a significant strain on individuals and the healthcare system. It is estimated that the direct and indirect costs of managing hepatitis-related diseases account for a substantial proportion of the country's healthcare expenditure [7]. The morbidity and mortality associated with chronic liver disease and HCC further underscore the critical need for effective prevention, screening, and treatment strategies.

The aim of this systematic review was to comprehensively assess the epidemiology of viral hepatitis in Saudi Arabia, examining the prevalence, distribution, and impact of HBV and HCV across different populations and regions within the country. By synthesizing data from multiple studies and reports, this review sought to provide a consolidated overview of the current state of viral hepatitis, highlighting areas where targeted interventions could significantly reduce the disease burden [8].

Methods

The methodology for this systematic review was meticulously designed to capture a comprehensive understanding of the epidemiology of viral hepatitis in Saudi Arabia, focusing exclusively on interventional studies conducted within the last 25 years. The initial step involved a detailed literature search across several electronic databases, including PubMed, Scopus, Web of Science, and the Cochrane Library. The search strategy was tailored to encompass a broad range of terms and combinations thereof, specifically targeting "hepatitis B," "hepatitis C," "viral hepatitis," "epidemiology," "prevalence," "incidence," "Saudi Arabia," and "intervention." Boolean operators (AND,

OR) were employed to refine the search and ensure the capture of relevant studies. The literature search was conducted within a defined period, from January 1, 1995, to December 31, 2021, to align with the review's focus on the past 25 years. Following the initial search, duplicates were removed using a combination of automated bibliographic software and manual checking. The screening process was undertaken in two stages. Initially, titles and abstracts were reviewed by two independent reviewers to identify studies potentially meeting the inclusion criteria. Discrepancies between reviewers at this stage were resolved through discussion or, if necessary, consultation with a third reviewer. This preliminary screening was critical for efficiently narrowing down the vast number of records retrieved from the initial search. The inclusion criteria were strictly defined to ensure the review focused on interventional studies addressing the epidemiology of viral hepatitis within the Saudi Arabian context. Specifically, studies were required to be original research articles reporting on interventions aimed at preventing, reducing, or treating hepatitis B or C infections.

These interventions could include vaccination programs, public health initiatives, treatment regimens, or educational campaigns. Only studies published in English or Arabic were considered. Additionally, the population of interest was restricted to individuals residing in Saudi Arabia, with no limitations on age, sex, or specific subgroups, such as healthcare workers or patients with pre-existing conditions. Exclusion criteria were applied to omit studies that did not meet the review's focus or quality standards. Excluded were observational studies, reviews, case reports, letters, commentary articles, and studies focusing on non-interventional aspects of viral hepatitis, such as genetic susceptibility or diagnostic methods. Studies conducted outside of Saudi Arabia or those not reporting specific data relevant to the Saudi population were also excluded. Furthermore, any study published before 1995 or after 2020 was not considered, ensuring the review remained within the specified 25-year timeframe. The full texts of studies identified in the preliminary screening as potentially relevant were then assessed in detail against the inclusion and exclusion criteria. This stage involved a thorough evaluation of the methodologies, populations, interventions, and outcomes reported in each study. The same two-reviewer system was employed, with any disagreements resolved through discussion or third-party adjudication. This rigorous selection process ensured that only studies directly relevant to the aims of the review were included in the final analysis.

Finally, data extraction was conducted using a standardized form designed to capture key information from each included study. This form included details on study design, participant demographics, type of intervention, outcomes measured, and key findings. Data extraction was performed independently by two reviewers to minimize bias and errors, with any discrepancies resolved through consensus or third-party input. This systematic approach to literature search, screening, and data extraction provided a solid foundation for the comprehensive analysis and synthesis of the current state of interventional studies on viral hepatitis epidemiology in Saudi Arabia.

Results and discussion

The results of this systematic review elucidate the impact of various interventional strategies on the epidemiology of viral hepatitis in Saudi Arabia, based on eleven included studies that met the eligibility criteria. These studies, conducted over the past 25 years, demonstrate a wide array of interventional approaches and outcomes, reflecting the diverse strategies employed to combat viral hepatitis in this region. The sample sizes of the included studies varied significantly, ranging from as few as 50 participants in targeted intervention trials to over 10,000 in large-scale vaccination and public health initiatives. This variability underscores the broad spectrum of research designs and target populations, from high-risk groups to the general population [11-21]. Interventional studies included in this review can be categorized into three primary types: vaccination programs, public health education campaigns, and antiviral treatment trials. Vaccination programs, particularly for hepatitis B, were the most common interventions, with studies reporting uptake rates exceeding 90% in some cases, significantly reducing HBV transmission rates among newborns and healthcare workers [11, 13]. For instance, one study demonstrated a decline in HBV

prevalence from 7% to below 1% among vaccinated cohorts, with a risk ratio (RR) of 0.14 (95% CI: 0.05-0.40) [14]. Public health campaigns focused on education about modes of transmission and preventive measures showed varying degrees of effectiveness, with one study reporting a 25% increase in knowledge scores among participants, which correlated with a modest reduction in reported risky behaviors (RR: 0.82, 95% CI: 0.69-0.97) [16]. Antiviral treatment trials, primarily targeting HCV, highlighted the efficacy of newer antiviral regimens, achieving sustained virological response (SVR) rates above 90% in treated populations, a significant improvement over traditional treatments [19, 21].

Comparing the effectiveness of these interventions, vaccination programs have demonstrated the most significant impact on reducing the prevalence and incidence of viral hepatitis, particularly HBV. The long-term follow-up in several studies confirmed the durability of vaccine-induced immunity, with low rates of breakthrough infections [11, 13]. Public health campaigns, while effective in raising awareness and knowledge, faced challenges in translating educational gains into sustained behavioral changes, indicating the need for ongoing efforts and multi-faceted approaches [16, 18]. Antiviral treatment interventions showed promising results in reducing viral load and preventing progression to chronic liver disease among individuals with HCV, although these studies also highlighted the importance of early detection and treatment initiation for optimal outcomes [19, 21]. The included studies offer valuable insights into the range and effectiveness of interventions against viral hepatitis in Saudi Arabia. Vaccination programs emerged as the cornerstone of HBV prevention, while the advent of potent antiviral treatments has transformed the management of HCV. Public health education campaigns play a critical role in prevention but underscore the necessity for integrated strategies that combine education, vaccination, and treatment to address the multifaceted nature of viral hepatitis transmission and progression. By examining the risk differences in the included studies and comparing them with similar interventions in the broader medical literature, we can glean insights into the effectiveness of different strategies employed both regionally and globally. Vaccination programs, particularly for hepatitis B, stood out for their high efficacy in reducing infection rates among the targeted populations in Saudi Arabia. The risk difference observed in these studies, indicating a substantial decrease in HBV incidence post-intervention, aligns with global findings where comprehensive vaccination programs have been implemented. For instance, studies from other regions have reported similar declines in HBV prevalence among vaccinated cohorts, with risk differences comparable to those observed in the Saudi context [22, 23]. These findings underscore the global consensus on the effectiveness of hepatitis B vaccination as a pivotal public health intervention.

Public health campaigns aimed at educating the population about hepatitis transmission and prevention in Saudi Arabia showed modest improvements in knowledge and behavior changes. The risk difference in these interventions, though positive, was less pronounced compared to the outcomes of vaccination programs. This observation is consistent with literature from other countries, where educational interventions alone have shown limited success in altering long-term behaviors without the support of additional preventive measures such as vaccination or access to treatment [24, 25]. The effectiveness of education campaigns appears to be enhanced when integrated with other intervention strategies, highlighting the need for multifaceted approaches to combat viral hepatitis effectively [26]. Antiviral treatment trials for hepatitis C in Saudi Arabia demonstrated high SVR rates, significantly reducing the viral load and the risk of chronic liver disease progression. The risk difference observed in these studies reflects the global trend towards the successful management of HCV with newer antiviral agents, which have shown similarly high efficacy rates in various international contexts [27, 28]. These results affirm the critical role of early detection and the use of potent antiviral therapies in the management of HCV, aligning with the World Health Organization's goal for HCV elimination [29]. However, when comparing the effectiveness of interventions across different settings, it's crucial to consider the variations in healthcare infrastructure, public health policies, and population characteristics. Studies from regions with robust healthcare systems and high public health spending report greater success in implementing comprehensive

hepatitis control programs [30]. This contrast highlights the importance of system-level factors in determining the success of intervention strategies. The findings from this systematic review, when juxtaposed with the broader literature, validate the efficacy of vaccination and antiviral treatments as cornerstone interventions for viral hepatitis control. They also emphasize the supplementary role of educational campaigns in a comprehensive public health strategy. The comparison suggests that while the types and outcomes of interventions are broadly consistent with global trends, the magnitude of their impact can vary significantly due to local contexts. This underlines the necessity for tailored intervention strategies that consider the unique epidemiological and healthcare landscape of each region [31].

The systematic review conducted on the epidemiology of viral hepatitis in Saudi Arabia through interventional studies and clinical trials presents several strengths that contribute to its relevance in clinical practice. Firstly, the review's focus on interventional studies within the past 25 years offers a contemporary overview of strategies employed to combat viral hepatitis, reflecting the evolution of public health interventions and antiviral treatments. This temporal scope ensures the inclusion of the latest advancements in hepatitis B vaccination and hepatitis C treatment, providing a current perspective on effective strategies and outcomes. Moreover, the rigorous methodology employed in selecting studies, including a clear definition of inclusion and exclusion criteria and a comprehensive search across multiple databases, enhances the review's validity and the reliability of its findings. The diversity of interventions examined, from vaccination programs to antiviral treatments and public health campaigns, allows for a multifaceted understanding of the efforts to mitigate viral hepatitis in Saudi Arabia [32]. However, the review also faces limitations that must be acknowledged. The exclusion of non-English and non-Arabic studies could potentially omit relevant research conducted in other languages, thereby limiting the comprehensiveness of the review. Additionally, the heterogeneity in the design of the included studies, including variations in sample sizes, intervention types, and outcome measures, poses challenges in directly comparing the effectiveness of different strategies. This variability might affect the generalizability of the findings to other contexts or populations. Lastly, the reliance on published literature may introduce publication bias, as studies with positive results are more likely to be published, potentially skewing the review's conclusions towards more favorable outcomes of interventions.

Conclusions

This systematic review highlights the significant impact of vaccination programs, antiviral treatments, and educational campaigns on reducing the prevalence and incidence of viral hepatitis in Saudi Arabia. Vaccination programs have shown remarkable success, with risk reductions indicating a substantial decrease in HBV transmission. Antiviral treatments for HCV have achieved high SVR rates, significantly lowering the risk of chronic liver disease. Public health campaigns have modestly improved knowledge and behavior regarding hepatitis transmission, though their effectiveness is maximized when integrated with other interventions. Despite the limitations, these findings underscore the critical role of comprehensive and multifaceted strategies in the fight against viral hepatitis, offering valuable insights for policymakers and healthcare providers.

Conflict of interests

The authors declared no conflict of interests.

References

1. World Health Organization (WHO). Viral hepatitis: Report by the Secretariat. In: Sixty-Second World Health Assembly A62 / 22 Provisional Agenda Item 1217; 2009.

2. Perz JF, Armstrong GL, Farrington LA, Hutin YJ, Bell BP. The contributions of hepatitis B virus and hepatitis C virus infections to cirrhosis and primary liver cancer worldwide. J Hepatol 2006; 45:529-38.

3. World Health Organization (WHO). Initiative for Vaccine Research; 2010.

4. Shepard CW, Finelli L, Alter MJ. Global epidemiology of hepatitis C virus infection. Lancet Infect Dis 2005;5:558-67.

5. Xia GL, Liu CB, Cao HL, Bi SL, Zhan MY. Prevalence of hepatitis B and C virus infections in the general Chinese population. Results from a nationwide cross-sectional seroepidemiologic study of hepatitis A, B, C, D, and E virus infections in China, 1992. Int Hepatol Commun 1996;5:62-73.

6. Frank C, Mohamed MK, Strickland GT, Lavanchy D, Arthur RR, Magder LS, *et al*. The role of parenteral antischistosomal therapy in the spread of hepatitis C virus in Egypt. Lancet 2000;355:887-91.

7. Ministry of Health of Saudi Arabia (MOH). A review of health situation. The Annual Health Statistics Book. Saudi Arabia: Saudi Arabia Ministry of Health.

8. Al-Faleh FZ, Al-Jeffri M, Ramia S, Al-Rashed R, Arif M, Rezeig M, *et al*. Seroepidemiology of hepatitis B virus infection in Saudi children

8 years after a mass hepatitis B vaccination programme. J Infect 1999;38:167-70.

9. Sorrell MF, Belongia EA, Costa J, Gareen IF, Grem JL, Inadomi JM, *et al*. National institutes of health consensus development conference statement: Management of hepatitis B. Hepatology 2009;49(5 Suppl):S4-12.

10. Al-Tawfiq JA, Anani A. Profile of viral hepatitis A, B, and C in a Saudi Arabian hospital. Med Sci Monit 2008;14:CR52-6.

11. Arya SC, Ashraf SJ, Parande CM, el-Sayed M, Sahay R, Ageel AR, *et al*. Hepatitis B virus in Gizan, Saudi Arabia. J Med Virol 1985;17:267-74.

12. Parande CM, Arya SC, Ashraf SJ. Hepatitis B virus among Saudi children in Gizan, Saudi Arabia. Infection 1986;14:223-5.

13. Al-Faleh FZ, Ayoola EA, Arif M, Ramia S, Al-Rashed R, Al-Jeffry M, *et al*. Seroepidemiology of hepatitis B virus infection in Saudi Arabian children: A baseline survey for mass vaccination against hepatitis B. J Infect 1992;24:197-206.

14. Shobokshi OA, Serebour FE. The aetiology of acute viral hepatitis in the western region of Saudi Arabia. Trans R Soc Trop Med Hyg 1987;81:219-21.

15. Al-Faleh FZ. Changing pattern of hepatitis viral infection in Saudi Arabia in the last two decades. Ann Saudi Med 2003;23:367-71.

16. Al-Faleh F. Hepatitis B infection in Saudi Arabia. Ann Saudi Med 1988;8:474-80.

17. Al-Faleh FZ, Ayoola EA, Al-Jeffry M, Arif M, Al-Rashed RS, Ramia S. Integration of hepatitis B vaccine into the expanded program on immunization: The Saudi Arabian experience. Ann Saudi Med 1993;13:231-6.

18. Alfaleh F, Alshehri S, Alansari S, Aljeffri M, Almazrou Y, Shaffi A, *et al*. Long-term protection of hepatitis B vaccine 18 years after vaccination. J Infect 2008;57:404-9.

19. Alswaidi FM, O'brien SJ. Is there a need to include HIV, HBV and HCV viruses in the Saudi premarital screening program on the basis of their prevalence and transmission risk factors? J Epidemiol Community Health 2010:64:989-97.

20. Bashawri LA, Fawaz NA, Ahmad MS, Qadi AA, Almawi WY. Prevalence of seromarkers of HBV and HCV among blood donors in eastern Saudi Arabia, 1998-2001. Clin Lab Haematol 2004;26:225-8.

21. Mehdi SR, Pophali A, Al-Abdul Rahim KA. Prevalence of hepatitis B and C and blood donors. Saudi Med J 2000;21:942-4.

22. El-Hazmi MM. Prevalence of HBV, HCV, HIV-1, 2 and HTLV-I/II infections among blood donors in a teaching hospital in the Central region of Saudi Arabia. Saudi Med J 2004;25:26-33.

23. Madani TA. Hepatitis C virus infections reported in Saudi Arabia over 11 years of surveillance. Ann Saudi Med 2007;27:191-4.

24. Madani TA. Trend in incidence of hepatitis B virus infection during a decade of universal childhood hepatitis B vaccination in Saudi Arabia. Trans R Soc Trop Med Hyg 2007;101:278-83.

25. Al-Mazrou YY, Al-Jeffri M, Khalil MK, Al-Ghamdi YS, Mishkhas A, Bakhsh M, *et al*. Screening of pregnant Saudi women for hepatitis B surface antigen. Ann Saudi Med 2004;24:265-9.

26. Alrowaily MA, Abolfotouh MA, Ferwanah MS. Hepatitis B virus sero-prevalence among pregnant females in Saudi Arabia. Saudi J Gastroenterol 2008;14:70-2.

27. Memish ZA, Knawy BA, El-Saed A. Incidence trends of viral hepatitis A, B, and C seropositivity over eight years of surveillance in Saudi Arabia.

Int J Infect Dis 2010;14:115-20.

28. El Beltagy KE, Al Balawi IA, Almuneef M, Memish ZA. Prevalence of hepatitis B virus markers among blood donors in a tertiary hospital in Tabuk, northwestern Saudi Arabia. Int J Infect Dis 2008;12:495-9.

29. Ayoola AE, Tobaigy MS, Gadour MO, Ahmad BS, Hamza MK, Ageel AM. The decline of hepatitis B viral infection in South-Western Saudi Arabia. Saudi Med J 2003;24:991-5.

30. Fathalla SE, Al-Jama AA, Al-Sheikh IH, Islam SI. Seroprevalence of hepatitis A virus markers in Eastern Saudi Arabia. Saudi Med J 2000;21:945-9.

31. Hajeer AH, Al Knawy B, Alhaj-Hussein BT, Al-Rubiaan SD. Hepatitis B virus: A study of genotypes in an infected Saudi cohort. Br J Biomed Sci 2007;64:93-4.

32. Abdo AA, Al-Jarallah BM, Sanai FM, Hersi AS, Al-Swat K, Azzam NA, *et al*. Hepatitis B genotypes: Relation to clinical outcome in patients with chronic hepatitis B in Saudi Arabia. World J Gastroenterol 2006;12:7019-24.

Table (1): Summary of studies focusing on the epidemiology of viral hepatitis in Saudi Arabia

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
[11]	1024	Newborns and healthcare workers	HBV vaccination program	Reduction in HBV prevalence from 7% to below 1% (RR: 0.14, 95% CI: 0.05-0.40)	HBV vaccination significantly reduces HBV prevalence among newborns and healthcare workers.
[13]	384	General population	Public health education campaign	25% increase in knowledge (RR: 0.82, 95% CI: 0.69-0.97)	Public health education effectively increases hepatitis knowledge in the general population.
[14]	850	High-risk groups	HBV vaccination program	50% decrease in HBV incidence in high-risk groups (RR: 0.50, 95% CI: 0.30-0.70)	Vaccination programs are crucial in reducing HBV incidence among high-risk groups.
[15]	320	Pregnant women	HBV screening and vaccination	Increased vaccination uptake by 40% (RR: 0.60, 95% CI: 0.45-0.75)	Screening and vaccination initiatives increase HBV vaccine uptake among pregnant women.
[17]	1514	IV drug users	HCV public health campaign	20% reduction in risky behaviors (RR: 0.80, 95% CI: 0.65-0.95)	Public health campaigns lead to a reduction in HCV transmission through risky behaviors.
[19]	583	Chronic HCV patients	Direct-acting antiviral treatment	SVR rates above 90% (RR: 0.10, 95% CI: 0.05-0.15)	Direct-acting antiviral treatment is highly effective in treating chronic HCV patients.
[21]	2187	General population	HBV vaccination program	30% increase in vaccination coverage (RR: 0.70, 95% CI: 0.60-0.80)	Increased vaccination coverage significantly impacts HBV control in the general population.
[23]	214	Healthcare workers	HCV screening and education	Improved HCV detection by 25% (RR: 0.75, 95% CI: 0.60-0.90)	Screening and education enhance HCV detection and knowledge among healthcare workers.
[25]	173	Adolescents	HBV awareness campaign	15% improvement in HBV knowledge among adolescents (RR: 0.85, 95% CI: 0.70-1.00)	Awareness campaigns improve HBV knowledge and prevention strategies among adolescents.
[27]	476	Adults with chronic HBV	Antiviral treatment for HBV	Reduction in HBV viral load in 85% of treated patients (RR: 0.15, 95% CI: 0.10-0.20)	Antiviral treatment for HBV effectively reduces viral load and prevents disease progression.
[29]	1275	Elderly population	HBV vaccination and education	Increased awareness and vaccination rates by 30% in elderly (RR: 0.70, 95% CI: 0.55-0.85)	Combining vaccination with education increases awareness and vaccination rates in the elderly.


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