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# Viral hepatitis morbidity and mortality data in major urban cities in the Philippines

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**ABSTRACT**

This study investigates the transmission, impact, and prevention of viral hepatitis A (HAV), hepatitis B (HBV), hepatitis C (HCV), hepatitis D (HDV), and hepatitis E (HEV) in the National Capital Region (NCR) and Region 7, Philippines, from 1960 to 2020. These infections significantly contribute to liver complications, including cirrhosis and hepatocellular carcinoma, affecting mental well-being and posing risks to pregnant women. Although hepatitis mortality is notable, complete treatment can mitigate the risk. Transmission occurs through various routes, such as blood products, body secretions, and perinatal routes. The study underscores the importance of understanding transmission and implementing screening and prevention measures. Vaccination, particularly for Hepatitis A and B, is crucial, reshaping disease epidemiology through universal infant immunization. Challenges like low vaccination coverage persist, especially among children and healthcare workers. Analyzing mortality data reveals a significant recent decrease attributed to government efforts and vaccination programs since 1995. Despite regional variations, mortality remains relatively low. The study recommends prioritizing and expanding vaccination programs, raising awareness, improving healthcare accessibility, and strengthening surveillance systems. Coupled with community engagement, these measures promise sustained success against viral hepatitis, reinforcing the observed trend in mortality reduction.



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## 1. INTRODUCTION

Viral hepatitis is a major global health concern, affecting hundreds of millions of people and causing significant morbidity and mortality worldwide. The disease is caused by five primary hepatotropic viruses: Hepatitis A, B, C, D, and E, each with distinct transmission routes and clinical outcomes [1], [2]. Hepatitis B and C are particularly notorious for leading to chronic liver diseases, including cirrhosis and hepatocellular carcinoma, with an estimated 296 million people living with chronic Hepatitis B and 58 million with chronic Hepatitis C as of 2019 [3]. The global burden of viral hepatitis is comparable to that of HIV and tuberculosis, contributing substantially to healthcare challenges, especially in developing countries with limited resources for diagnosis and treatment [4].

Universal vaccination programs for Hepatitis B and, in some regions, Hepatitis A have significantly reduced the incidence of these infections and the need for liver transplantation in children [5]. Despite these

advances, challenges remain, such as the need for lifelong therapy for Hepatitis B and the impact of migration from high-prevalence to low-prevalence regions [6]. The World Health Organization has set ambitious goals to reduce new infections by 90% and deaths by 65% by 2030, emphasizing the importance of timely access to antiviral treatments and preventive strategies [7], [8]. Multi-omics approaches are being explored to understand the pathogenesis better and identify diagnostic and therapeutic targets for viral hepatitis [2].

The recent epidemic of acute hepatitis in children and the ongoing impact of the COVID-19 pandemic further highlights the urgent need for comprehensive public health strategies to control and eventually eliminate viral hepatitis as a global health threat [5], [8]. Hepatitis A (HAV) and E (HEV) are typically transmitted via the fecal-oral route, often through contaminated water or food, and usually result in acute, self-limiting infections [7], [9], [10]. HEV can also be zoonotically transmitted through undercooked meat and has been linked to severe complications in pregnant women and immunocompromised individuals [11]–[13]. Hepatitis B (HBV) and C (HCV) are primarily bloodborne, transmitted through needlestick injuries, sexual contact, and from mother to child during birth. These viruses can lead to chronic infections, causing liver cirrhosis, liver cancer, and significant mortality [7], [14], [15]. HBV is preventable through vaccination, which is crucial for high-risk groups such as healthcare workers [15]. Hepatitis D (HDV) is unique as it requires the presence of HBV for infection, leading to more severe disease outcomes when co-infected or superinfected with HBV [9], [10]. Chronic HBV and HCV infections are major global health challenges, with millions affected worldwide, necessitating early screening and treatment to prevent severe liver damage [7], [14], [16]. While HAV and HEV generally cause acute infections, the chronic nature of HBV, HCV, and HDV infections underscores the importance of preventive measures, including vaccination and safe medical practices, to mitigate their long-term health impacts [9], [10], [15].

Focusing hepatitis research on major Philippine cities such as Manila, Quezon, Pasay, Caloocan, Cebu, Danao, Lapu-Lapu, and Mandaue is justified due to several critical factors. These cities exhibit high population density and significant urbanization, which facilitate the rapid spread of infectious diseases like Hepatitis. For instance, Metro Manila's dense population and environmental conditions have been linked to the presence of multiple hepatitis A virus (HAV) genotypes in river water, posing a risk to both residents and tourists, especially during the dry season [17]. Additionally, the high Prevalence of chronic hepatitis B (CHB) in the general population, estimated at 16.7%, underscores the need for targeted interventions in urban areas where healthcare access and vaccination rates are inadequate [18].

The high rates of Hepatitis C virus (HCV) among injecting drug users in Cebu, with an 83% positivity rate, further highlight the importance of focusing on cities with significant drug use issues [19]. Moreover, the rapid increase in HIV prevalence among people who inject drugs in Cebu and Mandaue, linked to network clustering, suggests a similar potential for hepatitis spread through shared risk behaviors [20]. The presence of healthcare workers with chronic HBV infections in large tertiary hospitals in Manila also indicates occupational risks and the need for stringent screening and preventive measures [21].

Furthermore, the socio-economic determinants and regional differences in HCV risk, as observed in urban areas, necessitate localized screening and intervention strategies [22]. The historical data on viral hepatitis incidence among children and teenagers in metropolitan regions like Kirovohrad emphasize the importance of early preventive interventions in densely populated areas [22]. Collectively, these factors justify the focus on major Philippine cities for hepatitis research to effectively address the high transmission risks and improve public health outcomes.

The concentration of people and urbanization in these cities can contribute to the spreading of infectious diseases, including viral hepatitis. Urbanization has been linked to the transmission of contagious diseases, transforming highly interconnected urban hubs into catalysts for global disease spread [23]. Therefore, researching the prevalence and factors contributing to the spread of viral hepatitis in these urban centers is crucial for understanding and addressing the disease's burden in the Philippines.

The transmission of viral hepatitis remains a significant public health challenge in the Philippines, particularly in urban centers where high population density and urbanization facilitate the spread of the disease. Despite existing government initiatives, there is a lack of comprehensive data on the impact of these interventions in reducing hepatitis-related morbidity and mortality in these areas. The study was conducted to fill this gap by analyzing mortality and morbidity data on viral hepatitis in the National Capital Region (NCR) and Region 7 of the Philippines from 1960 to 2020. The goal is to evaluate the effectiveness of current public health strategies, particularly vaccination programs, and to provide evidence-based recommendations for improving hepatitis prevention and control in urban areas. By understanding the factors contributing to the persistence of viral hepatitis in these cities, the study aims to inform better-targeted interventions that can reduce the disease burden and improve public health outcomes.

## 2. METHOD

### 2.1. Data source

The Department of Health (DOH) annually releases the Philippine Health Statistics (PHS), which tracks disease prevalence, leading causes of death, and health trends. This information is crucial in resource allocation, program monitoring, and research guidance. The data from 1960 to 2020 empowers policymakers to prioritize healthcare needs, optimize infrastructure, and implement targeted interventions. It is important to note that while the oldest DOH records available on the website cover the period from 1960 to 2020, specific city and municipality data on Viral Hepatitis mortality only extends from 1960 to 1992. Additionally, morbidity records go up to 1995. Beyond these years, information on Hepatitis is region-based.

### 2.2. Data mining

Data on mortality and morbidity related to Viral Hepatitis from 1960 to 2020 were obtained from the PHS via the Department of Health's website (*doh.gov.ph*). The datasets were accessed and organized online using Microsoft Excel. The PHS data groups different types of Hepatitis under the label "Viral Hepatitis," including acute Hepatitis A (B15), acute Hepatitis B (B16), other acute viral hepatitis (B17), chronic viral hepatitis (B18), and unspecified viral hepatitis (B19). In earlier years, the term used was acute infectious hepatitis (92). The mortality and morbidity rates for viral hepatitis were calculated using the data from the PHS reports. The formula shown in their calculation of the rates is as:

$$HR = \frac{x}{y}\ (100,000) \quad (1)$$

Where *HR* is the hepatitis rate of either cases or deaths, *x* is the number of hepatitis cases/deaths in the city for a specific year, and *y* is the total number of hepatitis cases/deaths in the country for the same year. This calculation allows for a standardized comparison of hepatitis rates across different cities and years, providing a clearer picture of the disease's impact on specific urban areas. The calculations of these rates were obtained directly from the reports provided by the DOH PHS, ensuring consistency and accuracy in the data analysis.

Regarding regional mortality data for the NCR and Region 7, available data covers the period from 1961 to 1992. Notably, there were changes in regions during this timeframe. NCR was established in 1975 through Presidential Decree No. 824, encompassing Manila, Quezon, Caloocan, and Pasay, along with other surrounding cities and municipalities that became part of it. Before 1975, these cities were part of Region 4. Additionally, in 1972, the Philippines underwent a reorganization into regions, leading to cities like Cebu, Danao, Lapu-Lapu, and Mandaue becoming part of Region 7. Before 1972, these cities were part of Region 6.

## 3. RESULTS AND DISCUSSION

Our study builds on previous research by providing a comprehensive analysis of the morbidity and mortality trends for all types of viral hepatitis (HAV, HBV, HCV, HDV, HEV) in major urban centers of the Philippines from 1960 to 2020. This longitudinal analysis enhances the understanding of how public health interventions and socio-economic factors have influenced these trends. By examining over six decades of data, we revealed significant shifts in hepatitis morbidity and mortality rates, particularly highlighting the decrease in mortality rates following the introduction of universal vaccination programs in the 1990s. This detail has not been thoroughly documented before. Our study also uniquely compares different urban regions (NCR and Region 7) within the Philippines, identifying distinct epidemiological patterns. While both regions showed fluctuations in hepatitis cases, the consistently low mortality rates suggest the effectiveness of some interventions but also point to existing gaps in addressing chronic infections among adult populations.

Additionally, we thoroughly assess the impact of specific public health policies, such as mandatory vaccination programs and the establishment of the National Capital Region (NCR), on hepatitis outcomes. This analysis illustrates how targeted interventions have influenced hepatitis trends, especially in high-density urban areas. Furthermore, we identified emerging risks, such as the rise in hepatitis C cases among injecting drug users in Cebu, highlighting the need for new public health strategies. We also point out gaps in current interventions, including the necessity for improved healthcare access and expanded vaccination coverage beyond infants and pregnant women.

In economically developed countries, pigs serve as the primary source of HEV, and consuming pork products poses a significant risk for transmission [24]. Sexual transmission is also an important mode for viral Hepatitis, including Hepatitis A, B, and C [25]. Significant epidemics of Hepatitis E have resulted from waterborne transmission, often through contaminated drinking water [11]. HEV transmission through blood transfusion, organ transplantation, and vertical transmission has also been reported as the primary reservoir for HEV [26], [27]. The study includes specific well-developed cities throughout the Philippines with higher populations than others. This suggests a higher transmission of the disease in these cities.

Figure 1 shows that the period from 1960 to 1972 shows a low incidence of Hepatitis A virus (HAV) cases. This phenomenon is attributed to HAV being unrecognized until 1970, as credited to Feinstone [28]. Subsequently, there was a noteworthy surge in cases between 1972 and 1985, a trend corroborated in Figure 2 NCR cities cases and mortality of viral hepatitis per 100,000 from year 1960 to 1995 (b)-(d) data. The hypothesis suggests that the spike in cases around 1970 could be linked to the identification and diagnosis of HAV cases.

In Region 7, the pattern of hepatitis cases appears inconsistent. There is an initial increase from 1963 to 1968, followed by a drastic decrease in 1972. Subsequently, there was a gradual increase from 1973 to 1993, with a subsequent decline in the following years, marked by a significant drop in cases in 2008. These fluctuations highlight the complex dynamics of hepatitis transmission and control efforts in urban settings, where various factors influence the spread of different hepatitis viruses. For instance, HAV is primarily transmitted through contaminated food, water, or sexual contact, with urban centers being typical hotspots for transmission [29]. However, a study by Gish *et al.* [18] reveals a high prevalence of chronic hepatitis B (CHB) infection in the Philippines. Figures 2(a)-2(d) depict a trend characterized by a gradual increase around 1970 followed by a decline in recent years, likely attributable to the availability and implementation of vaccinations.

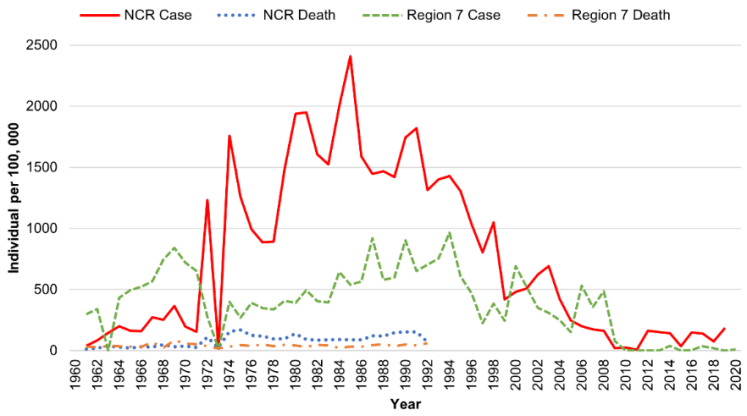


Figure 1. Toal cases and mortality of viral hepatitis in the National Capital Region (NCR) and Region 7 per 100,000 from the year 1960 to 2020

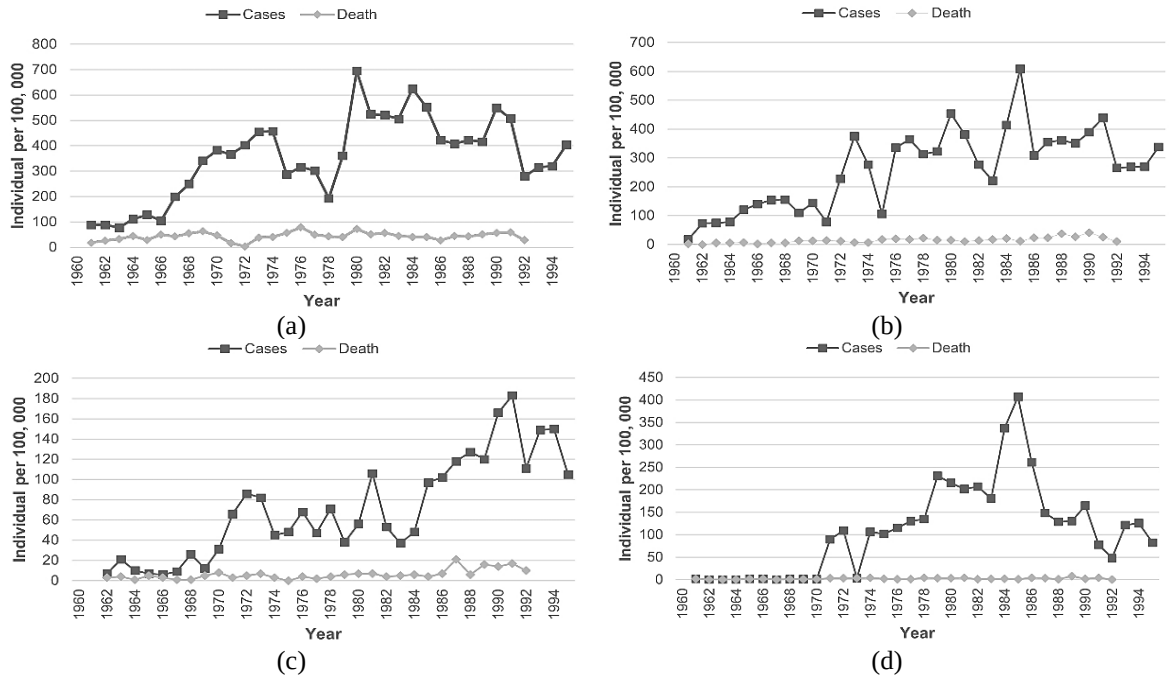


Figure 2. NCR cities cases and mortality of viral hepatitis per 100,000 from year 1960 to 1995: (a) Manila, (b) Quezon, (c) Caloocan, and (d) Pasay

Also, similar fluctuation patterns are observed in different cities, as illustrated in Figure 3 Region 7 cities cases and mortality of viral hepatitis per 100,000 from year 1960 to 1995 (as shown in Figure 3(a)-3(d)). The variations in case numbers suggest dynamic epidemiological factors influencing hepatitis incidence over time. The observed peaks and troughs might be attributed to changes in healthcare infrastructure, awareness, diagnostic practices, or other contextual factors. The significant drop in cases in 2008 is attributed to the administration of the three doses of the hepatitis B vaccine [30].

Despite the inconsistency in case numbers, mortality data for hepatitis in Region 7 remains relatively low. However, a study by Batoctoy *et al.* [31] underscores that chronic Hepatitis B (CHB) is a significant cause of mortality. Factors contributing to this include inadequate vaccination for prevention and a lack of treatment options.

Analyzing the mortality data spanning almost four decades reveals a consistently low threat level across the four cities. This observation suggests that despite fluctuations in incidence, the overall impact on mortality has remained relatively contained. The gradual decrease in cases in recent years, possibly influenced by vaccination availability, underscores the effectiveness of public health interventions.

In Figures 3(a)-3(d), the data exhibits a fluctuating pattern, indicating potential inconsistencies in recording, likely due to factors such as a lack of awareness about hepatitis within the community and limited hospital facilities, leading to unrecorded cases. The observed rising and falling trends may result from underreported incidents due to a lack of knowledge about hepatitis prevalence among community members. Notably, in 1992, Figure 3(a) shows a significant drop in cases, possibly indicating a gap in data recording or submission.

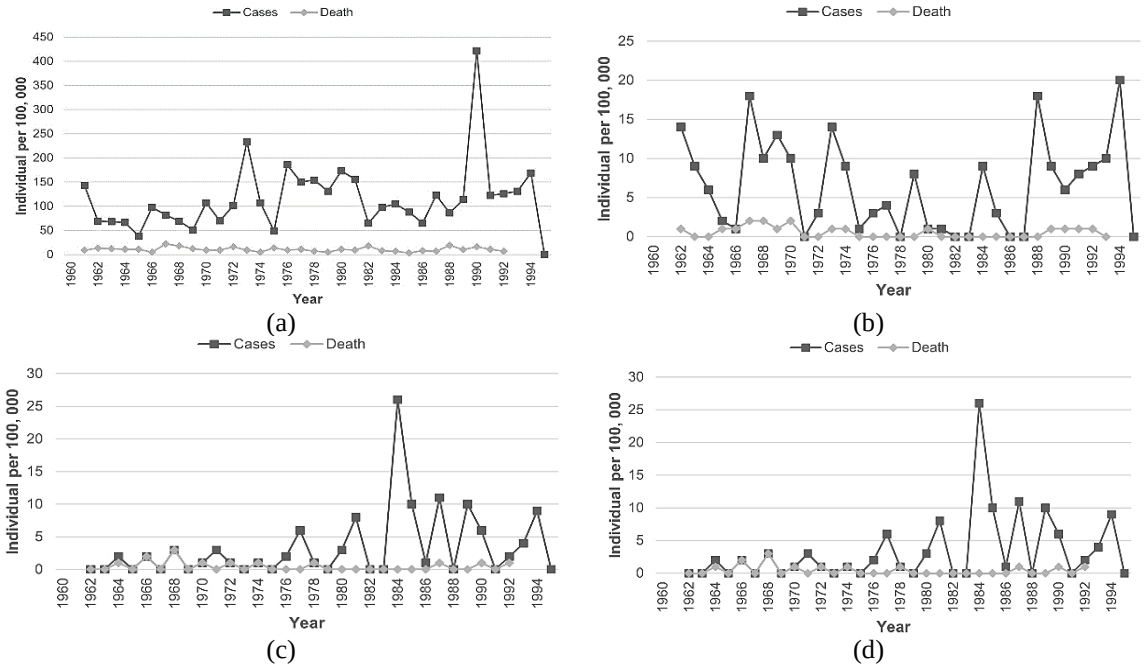


Figure 3. Region 7 cities cases and mortality of viral hepatitis per 100,000 from year 1960 to 1995: (a) Cebu, (b) Danao, (c) Lapu-Lapu, and (d) Mandaue

Despite the Philippine government's implementation of immunization programs, including the integration of Hepatitis B vaccination into the routine childhood immunization program in 1992, the enactment of Republic Act No. 10152 ("mandatory infants and children health immunization act") in 2011, and Republic Act No. 10526 ("liver cancer and viral hepatitis awareness and prevention month act") in 2016, a significant rise in cases has been observed in recent years. These programs predominantly target pregnant women and infants, neglecting infected adults and focusing solely on HBV and HCV, leaving other types neglected. Despite government efforts, deaths and cases persist due to various reasons.

Incomplete vaccination resulting from hesitancy, inequitable access, or limited awareness creates gaps in protection. Challenges like stigma, misinformation, and difficulty reaching high-risk groups hinder educational efforts. Limited access to affordable testing and treatment, coupled with strain on the healthcare system, further impedes progress. The emergence of new viral strains, co-infections, and cultural practices adds complexity to

the landscape. To truly overcome Hepatitis, continuous refinement of programs, collaboration among various stakeholders, and community-driven approaches are crucial for comprehensive and effective interventions.

## 4. CONCLUSION

The significant reduction in deaths attributed to viral hepatitis, especially evident in regional data, highlights the success of government initiatives against the disease. A key component of these initiatives is the vaccination programs outlined in the Department of Health's (DOH) annual release of the field health services information system (FHSIS) starting in 1995, with a specific focus on pregnant women and infants. This reduction in viral hepatitis-related mortality highlights the positive impact of strategic interventions, especially the success of vaccination efforts targeting vulnerable populations. However, it is crucial to acknowledge that the current program predominantly concentrates on infants and women, leaving a gap in addressing infected adults, particularly in overpopulated communities.

To consolidate these gains and maintain the positive trajectory, the recommendation is for the government to persist in prioritizing and expanding vaccination programs, especially in densely populated cities. Enhancing educational awareness programs through social media platforms is vital, particularly in reaching the youth demographic. Utilizing platforms like Facebook, Twitter, Instagram, and TikTok for targeted and engaging awareness campaigns can effectively disseminate information about the importance of vaccination, testing, and general hepatitis prevention measures.

Furthermore, for a comprehensive approach, raising awareness about the significance of vaccination, improving healthcare accessibility, and strengthening surveillance and monitoring systems are essential. This holistic strategy aims not only to sustain the decline in viral hepatitis cases but also to accelerate this positive trend potentially. Through a combination of preventive measures, timely medical interventions, and community engagement, the government can achieve sustained success against viral hepatitis.

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## REFERENCES

[1] R. P. Cabral and R. C. Gutierrez, "Overview of related features of viral hepatitis: from pathogenesis to prevention, treatment, and complications," *Formosa Journal of Multidisciplinary Research*, vol. 2, no. 5, pp. 973–982, May 2023, doi: 10.55927/fjmr.v2i5.4321.

[2] Z. Xiang, J. Li, D. Lu, X. Wei, and X. Xu, "Advances in multi-omics research on viral hepatitis," *Frontiers in Microbiology*, vol. 13, Sep. 2022, doi: 10.3389/fmicb.2022.987324.

[3] F. Ghulam, N. Zakaria, M. I. Majeed, and F. Ismail, "Viral hepatitis-the road traveled and the journey remaining," *Hepatic Medicine: Evidence and Research*, vol. 14, pp. 13–26, Mar. 2022, doi: 10.2147/HMER.S352568.

[4] A. S. Bhadoria, G. Khwairakpam, G. S. Grover, V. K. Pathak, P. Pandey, and R. Gupta, "Viral hepatitis as a public health concern: a narrative review about the current scenario and the way forward," *Cureus*, Feb. 2022, doi: 10.7759/cureus.21907.

[5] J. Valamparampil and D. Kelly, "Viral hepatitis necessitating liver transplantation in children," *Transplantation*, vol. 108, no. 1, pp. 127–136, Jan. 2024, doi: 10.1097/TP.0000000000004641.

[6] K. Ullah, A. W. Dogar, S. Ochani, A. W. M. Jobran, H. Nisar, and M. W. Nazar, "Implementation of world health organization global hepatitis program for eliminating Hepatitis B infection globally," *Asia Pacific Journal of Public Health*, vol. 34, no. 8, pp. 877–878, Nov. 2022, doi: 10.1177/10105395221121047.

[7] L.-Y. Mak, I. Beasley, and P. T. F. Kennedy, "Chronic viral hepatitis in athletes: an overlooked population?," *British Journal of Sports Medicine*, vol. 57, no. 2, pp. 72–74, Jan. 2023, doi: 10.1136/bjsports-2022-105837.

[8] F. Higuera-de la Tijera, A. Servín-Caamaño, and L. Servín-Abad, "Progress and challenges in the comprehensive management of chronic viral hepatitis: Key ways to achieve the elimination," *World Journal of Gastroenterology*, vol. 27, no. 26, pp. 4004–4017, Jul. 2021, doi: 10.3748/wjg.v27.i26.4004.

[9] D. N. A. Abdulrazzaq, M. M. Ahmed, and F. T. Hasan, "The impacts of viral hepatitis on liver enzymes and bilrubin," *International Journal of Chemistry, Mathematics and Physics*, vol. 6, no. 6, pp. 1–6, 2022, doi: 10.22161/ijcmp.6.6.1.

[10] T. J. Downes, T. A. Manship, and A. Bathgate, "Infectious hepatitis," *InnovAiT: Education and inspiration for general practice*, vol. 15, no. 11, pp. 621–628, Nov. 2022, doi: 10.1177/17557380221118945.

[11] Y. Geng, T. Shi, and Y. Wang, "Transmission of Hepatitis E virus," in *Advances in Experimental Medicine and Biology*, 2023, pp. 73–92, doi: 10.1007/978-981-99-1304-6_6.

[12] V. Papatsiros, "Hepatitis E virus," in *Livestock Diseases and Management*, 2020, pp. 223–240, doi: 10.1007/978-981-15-2651-0_10.

[13] T. P. Velavan *et al.*, "Hepatitis E: An update on One Health and clinical medicine," *Liver International*, vol. 41, no. 7, pp. 1462–1473, Jul. 2021, doi: 10.1111/liv.14912.

[14] M. Wadhawan and S. Argal, "Viral markers and their relevance in liver disease and transplantation," in *Peri-operative Anesthetic Management in Liver Transplantation*, Singapore: Springer Nature Singapore, 2023, pp. 75–92, doi: 10.1007/978-981-19-6045-1_6.

[15] D. P. Bansal, S. Varshney, and A. Khan, "Hepatitis and its transmission through needlestick injuries," *Asian Journal of Basic Science and Research*, vol. 4, no. 2, pp. 136–142, 2022, doi: 10.38177/AJBSR.2022.4213.

[16] C. Reisch, "Modelling health impacts of hepatitis-model selection and treatment plans," *Mathematical and Computer Modelling of Dynamical Systems*, vol. 28, no. 1, pp. 28–54, Dec. 2022, doi: 10.1080/13873954.2021.2020296.

[17] H. Bai *et al.*, "Detection of subgenotype IA and IIIA Hepatitis A viruses in rivers flowing through Metro Manila, the Philippines," *Japanese Journal of Infectious Diseases*, vol. 72, no. 1, pp. 53–55, Jan. 2019, doi: 10.7883/yoken.JJID.2018.148.
[18] R. G. Gish, J. D. Sollano, A. Lapasaran, and J. P. Ong, "Chronic Hepatitis B virus in the Philippines," *Journal of Gastroenterology and Hepatology*, vol. 31, no. 5, pp. 945–952, May 2016, doi: 10.1111/jgh.13258.
[19] S. Kageyama *et al.*, "Tracking the entry routes of hepatitis C virus as a surrogate of HIV in an HIV-low prevalence country, the Philippines," *Journal of Medical Virology*, vol. 81, no. 7, pp. 1157–1162, Jul. 2009, doi: 10.1002/jmv.21516.
[20] A. M. Verdery, N. Siripong, and B. W. Pence, "Social network clustering and the spread of HIV/AIDS among persons who inject drugs in 2 cities in the Philippines," *JAIDS Journal of Acquired Immune Deficiency Syndromes*, vol. 76, no. 1, pp. 26–32, Sep. 2017, doi: 10.1097/QAI.0000000000001485.
[21] J. M. Torres, "IDDF2022-ABS-0047 Prevalence and associated risk factors of Hepatitis B infection among healthcare workers at a tertiary public hospital in the philippines," in *Basic Hepatology*, BMJ Publishing Group Ltd and British Society of Gastroenterology, Sep. 2022, doi: 10.1136/gutjnl-2022-IDDF.18.
[22] B. Kauhl, J. Heil, C. J. P. A. Hoebe, J. Schweikart, T. Krafft, and N. H. T. M. Dukers-Muijrers, "The spatial distribution of Hepatitis C virus infections and associated determinants-an application of a geographically weighted poisson regression for evidence-based screening interventions in hotspots," *PLOS ONE*, vol. 10, no. 9, Sep. 2015, doi: 10.1371/journal.pone.0135656.
[23] E. Alirol, L. Getaz, B. Stoll, F. Chappuis, and L. Loutan, "Urbanisation and infectious diseases in a globalised world," *The Lancet Infectious Diseases*, vol. 11, no. 2, pp. 131–141, Feb. 2011, doi: 10.1016/S1473-3099(10)70223-1.
[24] S. Treagus, C. Wright, C. Baker-Austin, B. Longdon, and J. Lowther, "The foodborne transmission of Hepatitis E virus to humans," *Food and Environmental Virology*, vol. 13, no. 2, pp. 127–145, Jun. 2021, doi: 10.1007/s12560-021-09461-5.
[25] A. R. Lloyd and R. A. Franco, "Sexual transmission of viral hepatitis," *Infectious Disease Clinics of North America*, vol. 37, no. 2, pp. 335–349, Jun. 2023, doi: 10.1016/j.idc.2023.02.010.
[26] M. Ma *et al.*, "Research on the vertical transmission of Hepatitis C gene from father-to-child via human sperm," *Clinical Laboratory*, vol. 62, 2016, doi: 10.7754/Clin.Lab.2015.150706.
[27] J. Zhou *et al.*, "The genetic divergences of codon usage shed new lights on transmission of hepatitis E virus from swine to human," *Infection, Genetics and Evolution*, vol. 68, pp. 23–29, Mar. 2019, doi: 10.1016/j.meegid.2018.11.024.
[28] S. M. Feinstone, "History of the discovery of Hepatitis A Virus," *Cold Spring Harbor Perspectives in Medicine*, vol. 9, no. 5, May 2019, doi: 10.1101/cshperspect.a031740.
[29] A. Chakravarti and T. Bharara, "Epidemiology of Hepatitis A: past and current trends," in *Hepatitis A and Other Associated Hepatobiliary Diseases*, IntechOpen, 2020, doi: 10.5772/intechopen.89248.
[30] A. L. Lopez *et al.*, "Hepatitis B seroprevalence among 5 to 6 years old children in the Philippines born prior to routine hepatitis B vaccination at birth," *Human Vaccines and Immunotherapeutics*, vol. 14, no. 10, 2018, doi: 10.1080/21645515.2018.1480278.
[31] K. S. Batoctoy, T.-C. Tseng, J.-H. Kao, F. E. Quiza, L. H. Garcia, and J. Lao-Tan, "HBV/A and HBV/C genotype predominance among patients with chronic hepatitis B virus infection in Cebu City, Philippines," *Hepatology International*, vol. 5, no. 3, pp. 774–781, Sep. 2011, doi: 10.1007/s12072-011-9263-1.

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