

Vaccine Prophylaxis of Viral Hepatitis B among the Adult Population in the City of Jalal-Abad (Kyrgyz Republic)

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Abstract: Hepatitis B virus remains a significant public health threat, especially in regions with limited access to healthcare services. The main objective of the study was to assess the effectiveness of vaccination and identify the main barriers to its implementation, which could serve as a basis for optimizing immunization programmes in the region. In Jalal-Abad (Kyrgyz Republic), the screening study showed that the vaccination coverage rate among the adult population was critically low at only 3%, which is significantly lower than the level required for the formation of herd immunity. In 2023, 2,126 people were tested out of a total of 71,307 adult residents of the city, which is only 3% of the target group. A positive result for HBsAg was found in 70 people (3.3%). The vaccination procedure was completed by 2,483 people, most of whom were in the 50–59 age group (63.4 per 1,000 population). Gender analysis showed that 68.1% of those vaccinated were women, while the share of men was only 31.9%. The study identified a number of barriers, including limited access to healthcare services, lack of awareness of the risks of hepatitis B and the importance of vaccination, and logistical challenges. The findings support expanding vaccination through mobile units, integrated public health services, and culturally adapted information campaigns to improve uptake and reduce hepatitis B prevalence among underserved adults.

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Introduction

The spread of hepatitis B virus (HBV) among adults remains an important public health problem in many countries around the world. Vaccination is a key means of preventing transmission, but vaccination coverage among adults is often insufficient. Regional characteristics, such as socioeconomic status, access to healthcare services, and public awareness, have a significant impact on the effectiveness of immunization programmes. In Jalal-Abad, Kyrgyz Republic, the spread of HBV and limited access to preventive measures are a major concern.

As of 2022, according to WHO (World Health Organization, 2025), about 254 million people worldwide are living with chronic hepatitis B. About 1.2 million new cases are reported annually, and deaths from HBV (including cirrhosis and liver cancer) are estimated at around 1.1 million people. The infection is transmitted through contact with contaminated body fluids or from mother to child (Berezenko et al., 2021; Rudyk et al., 2024).

Thomas (2019) focused on global efforts to eliminate chronic hepatitis. The focus was on the integration of effective public health policies, progress in antiviral treatment, and achievements in expanding access to vaccination. It was noted that comprehensive approaches have significantly reduced the incidence, although many countries face difficulties in implementing these measures due to insufficient access to health services. Limited analysis of socio-economic barriers and the impact of political factors on the implementation of chronic hepatitis elimination programmes can be considered a gap.

Akmatov et al. (2023) analysed the seroepidemiological status of viral hepatitis in the capital of Kyrgyzstan, Bishkek. The study involved 1,075 people, among whom they tested for markers of viral hepatitis A, B, C, D and E. It was found that the seroprevalence of the HBV surface antigen (HbsAg) was 2.2% (95% confidence interval: 1.5–3.3%), and seropositivity to hepatitis D (anti-HDV) was recorded in 15% (5 out of 33 people with HBsAg). The results showed that Kyrgyzstan can be reclassified from a highly endemic to an intermediate endemic area for HBV. The main gap in the study is the insufficient analysis of social determinants of access to vaccination and medical care.

Woodring et al. (2019) analysed progress in the fight against mother-to-child transmission of HBV in the Western Pacific region from 2005 to 2017. Thanks to timely vaccination, the prevalence of HBV among children under 5 years of age has decreased to less than 1%. The main challenge of the study was to examine the effectiveness of vaccination programmes,

and the gap is the lack of analysis of the impact of social and cultural factors on vaccination coverage.

Zhang et al. (2022) investigated changes in the prevalence of HBV from 1990 to 2019. It found a significant reduction in morbidity and mortality due to vaccination, although regional inequalities remain a challenge. The study highlights that many countries are still far from achieving the WHO's goal of eliminating hepatitis by 2030. Among the gaps is the limited attention to socioeconomic barriers to access to care. Bixler et al. (2023) focused on the impact of national vaccination and screening programmes. It was found that the rate of infection among young people has significantly decreased, but cases among adults remain stable, especially among people who inject drugs. The main gap is not enough coverage of prevention programmes among the most vulnerable populations.

Wallace et al. (2022) focused on analysing the social and economic impact of introducing a potential treatment for hepatitis B. The results emphasize the importance of developing policies to ensure access to treatment for all populations. A gap is the lack of attention to the impact of cultural differences on treatment access. Delam et al. (2023) analysed the increase in the prevalence of HBV and C in Fars between 2015 and 2021. A significant increase in the incidence rate was found, indicating the need to strengthen preventive measures. However, it didn't focus on educational programmes to prevent new infections.

Julien et al. (2024) reviewed 333 scientific articles published over the past decade to assess key themes in prevention. They found that most attention was paid to transmission, especially vertical and perinatal transmission, vaccination, and antiretroviral treatment. Among the gaps identified is the need to create new educational initiatives, implement and evaluate their effectiveness, as well as to conduct further analysis of regional differences in the availability of health services.

While numerous studies have examined various aspects of hepatitis B, there is a lack of research that analyses the extent and specifics of vaccine prevention among adult residents of Jalal-Abad specifically. The aim of the study was to evaluate rapid testing and vaccination against hepatitis B among the adult population in the city of Jalal-Abad. To achieve this goal, the following study objectives were completed: to assess the hepatitis B vaccination coverage of the adult population of Jalal-Abad and identify the main demographic and socioeconomic factors affecting coverage, to identify barriers to access to hepatitis B vaccination in Jalal-Abad, to investigate the relationship between vaccination coverage and hepatitis B incidence in Jalal-Abad.

Material and Methods

Research design and setting

This screening survey was conducted in the city of Jalal-Abad during 2023 (from January to December) to study the effectiveness of hepatitis B vaccination among the adult population. In addition to the main objectives, the number of people who decided to be vaccinated during 2023 was studied to assess the dynamics of vaccination decision-making and identify possible factors influencing this process. The study covered nine groups of family doctors (GFD) in Jalal-Abad (GFDs No. 1–9) and the Central City Clinical Hospital, which included the Jalal-Abad City Family Medicine Center (FMC).

Characteristics of the study sample

The study covered the population over 18 years of age, with a total population of 71,307 out of 119,928 residents in the city. A total of 2,126 people participated in HBV testing, which was 3% of the total adult population (18 to 60 years and older). The sample included individuals aged 18 to 60 years and older who lived in Jalal-Abad, provided informed consent, had no recorded contraindications to vaccination, and agreed to participate in HBsAg testing (rapid test or ELISA), regardless of whether they had been vaccinated previously. Based on the analysis of data from the HBV Vaccination Registration Journal, it was determined that anyone who refused testing and/or vaccination, had severe allergic reactions to vaccine components or acute infectious or somatic diseases at the time of the visit, as well as those under the age of 18 were excluded from participation. Adherence to these criteria allowed us to cover different age groups (18–29, 30–39, 40–49, 50–59, 60+ years), as well as to involve both working people (healthcare workers, educators, service workers, etc.) and non-working citizens. This minimized systematic errors and ensured greater reliability of the survey findings. The representativeness of the sample was ensured by the inclusion of people of different ages, genders and social status. The gender distribution of the vaccinated sample was 68.1% women and 31.9% men. The total number of people who applied for the first dose of the vaccine was 2,483.

Data sources and tools

The data was obtained by analysing the statistical reports of the GFD. To ensure the accuracy and reliability of the study, the following main sources were used, covering the period from January to December 2023: the Medical Information Department of the Family Medicine Centre (FMC) – to obtain aggregate data on population size, testing and vaccination

coverage, registers (Medical Information Department of the FMC of Jalal-Abad [Regional Center of Family Medicine, 2025] – to obtain aggregated data on population size, testing and vaccination coverage, “Form of HBV testing registration log” of the rapid testing room in family doctor groups, “Registration log of persons with positive HBV results”, “Registration log of HBV vaccination” of the vaccination room [Medical and Diagnostic Center of the Central Medical and Economic Institute, 2023]), medical records of patients with positive rapid test results, which allowed us to collect information on health status, possible routes of infection and epidemiological history, laboratory testing data, including the results of ELISA performed at the Oblast AIDS Centre to confirm HBsAg status.

Vaccination and testing procedure

Rapid testing for HBsAg using certified SD BIOLINE HBsAg test kits (Standard Diagnostics, Inc., South Korea) in the offices of the GFD. ELISA was performed in the laboratory of the regional centre for acquired immunodeficiency syndrome (AIDS) to confirm the diagnosis in those with positive rapid tests. Recombinant vaccines were used for vaccination, such as Engerix-B from the Centre for Genetic Engineering and Biotechnology (CIGB) in Cuba, from GSK Biologicals (Belgium) and Heberbiovac HB (Cuba).

The vaccination was carried out in several stages:

- 1) Administration of the first dose of the vaccine.
- 2) Re-administration in 1 month.
- 3) Final dose 6 months after the first vaccination.
- 4) Each stage was recorded in the vaccination logs to ensure further monitoring.

To study the number of people who decided to be vaccinated, data from the HBV Vaccination Registration Journal were used. Information about each vaccinated patient was collected and analysed. The data were quantitatively sorted by two main parameters: frequency of visits to different GFDs – the number of visits for vaccination to each of the nine GFDs in Jalal-Abad (GFDs 1–9) was counted; and vaccine doses – the data were divided by the number of doses received (first, second, third), which allowed us to track the dynamics of vaccination and determine how many people completed the full course.

Training of medical staff was a key stage of the study. All involved specialists underwent specialized training, which included: seminars on organizing and conducting rapid testing and vaccination, practical training on procedures for collecting biomaterial for ELISA, and instruction on keeping registration logs and filling out medical records. This approach ensured standardization of procedures and minimized the possibility of errors during data collection. The testing

and vaccination procedures were coordinated through the healthcare facilities of the GFD, which provided conditions for vaccine storage and vaccination. Each stage was documented, and the data was entered into the relevant logs for further analysis.

Ethical considerations

The study was conducted in compliance with the ethical principles of the Declaration of Helsinki (World Medical Association, 2013). All study participants provided written informed consent to participate in the study and to the processing of their personal data. The confidentiality of the participants' data was guaranteed.

Statistical data processing methods

The collected data were subject to analytical and statistical processing. For this purpose, a personal computer with Excel 2002 software equipped with an analysis package for Windows XP was used. Statistical methods such as hypothesis testing (*t*-test, χ^2 -test), trend analysis, regression analysis (linear and logistic regression) and correlation analysis (determination of Pearson's correlation coefficient) were used to analyse the data obtained. This made it possible to identify correlations between vaccination coverage rates and a number of factors (age, gender, social status), as well as to assess the statistical significance of the differences identified. The dynamics of vaccination requests was monitored throughout 2023 by quarters (January–March, April–June, July–September, October–December). Possible seasonal factors (holiday season, SARS epidemic season) that could affect the frequency of applications were considered.

Results

Effectiveness and barriers of hepatitis B vaccination

Hepatitis B is one of the most important global public health problems, characterized by a complex epidemiology, a high burden of chronic infection and an association with severe complications. It is estimated that more than 257 million people worldwide are living with chronic hepatitis B, with the majority of infections occurring in regions with limited access to vaccination and healthcare services (Stasi et al., 2020). Epidemiological studies indicate significant demographic differences: the highest burden of the disease falls on Asian populations, in particular due to the high prevalence of B and C genotypes of the virus, which is also associated with clinical features of the disease. For example, patients with these genotypes often have a more favourable fibrosis profile but are

prone to developing serious complications such as cirrhosis and hepatocellular carcinoma (Coffin et al., 2019; Tutchenko et al., 2024a, b).

The immune response to hepatitis B plays a key role in determining the outcome of the infection, but the adaptive immune system, in particular CD8+ T cells, not only ensures viral clearance but also contributes to the progression of liver damage. Chronic infection is accompanied by immune dysfunction, including immune cell depletion, which limits the effectiveness of the body's fight against the disease and contributes to its chronicity (Kucherenko et al., 2019; Iannacone and Guidotti, 2021). One of the important features is the oncogenic potential of the virus, in particular through the integration of viral DNA into the hepatocyte genome, which triggers carcinogenic processes. The accumulation of genetic mutations due to chronic inflammation and cell regeneration creates conditions for the development of hepatocellular carcinoma, especially in men, due to the effect of androgens on viral replication (Nikolaev et al., 2021, 2022; Wang et al., 2021).

Although vaccination has significantly reduced the level of vertical and horizontal transmission among children, the adult population, including migrants from endemic regions, remains the main risk group. Another problem is the low level of vaccination coverage in high-risk groups, such as men who have sex with men (Fanning et al., 2019). Scientific studies, such as those by Davlidova et al. (2020), confirm that HBV remains a significant health problem in Kyrgyzstan, in particular due to high levels of migration, insufficient availability of preventive measures such as vaccination, and the spread of infection among the population. One review noted that in Central Asia, including Kyrgyzstan, the prevalence of HBV is significantly higher in certain risk groups, including people who inject drugs, migrants, and prisoners.

Hepatitis B virus has several routes of transmission, including vertical transmission from mother to child during pregnancy or childbirth, horizontal transmission through contact with blood or body fluids, as well as through sexual contact and reuse of unsterile medical equipment (Mamontov et al., 2023a, b). The main routes of transmission are horizontal transmission among family members and through procedures involving contact with blood, such as medical interventions or the use of shared instruments such as needles or razors.

Vertical transmission of HBV remains a significant problem, especially in high endemicity regions. Studies show that the risk of mother-to-child transmission increases significantly in the absence of new-born vaccination or immunoprophylactic measures (Villa and Navas, 2023). In Kyrgyzstan, new-born vaccination

and access to immunoglobulins have significantly reduced the number of new infections among infants. These measures are not always available in all regions of the country. In addition to vertical transmission, horizontal transmission, including household contact, remains a significant risk, especially among children living in families with infected members. Studies have highlighted the importance of vaccinating all family members who come into contact with patients, as well as informing the population about the risks of HBV transmission in the home (Zheng et al., 2022). Key populations at risk include healthcare workers, people requiring regular medical interventions (e.g., haemodialysis patients), prisoners, and people living with infected relatives. High rates of infection among these groups are associated with limited availability of preventive measures and lack of awareness of prevention methods (Varghese et al., 2021).

Prevention of HBV is based on the use of effective vaccines and ensuring access to preventive measures for all population groups. Hepatitis B is one of the few infectious diseases against which a highly effective vaccine is available, which not only prevents infection but also reduces the risk of complications such as cirrhosis and hepatocellular carcinoma (Tarasyuk et al., 2013; Berezenko et al., 2022). The main vaccines are recombinant products that have a high safety profile and provide immunological protection for many years. Recommended vaccination regimens include three doses administered at 0, 1 and 6 months. This standard regimen provides long-term immunity in more than 95% of vaccinated individuals. The dose given to new-borns within the first 24 hours after birth (HepB-BD) plays a special role, as it is key to prevent vertical transmission from mother to child. Studies have shown that this dose in combination with a full course of vaccination reduces the risk of chronic infection by up to 1% in children born to infected mothers (Woodring et al., 2019).

In addition to vaccination, an important component of prevention is immunoglobulin prophylaxis for new-borns who are at high risk of infection (for example, if the mother has a high viral load). The combination of immunoglobulin and vaccine during the first hours of life effectively blocks transmission, even in high-risk cases (Zhao et al., 2020). For adults in high-risk groups, such as healthcare workers, haemodialysis patients, people who inject drugs, and those who have multiple sexual partners, vaccination is also recommended (Nikolaev et al., 2025). In such cases, it is recommended to test for HBsAg antibodies after a certain time after vaccination to ensure that adequate immune protection is in place. For people with a weak immune response or certain chronic diseases, regimens with higher doses or additional

doses have been developed (Shulgau et al., 2017; Yao et al., 2024).

Despite this, the implementation of vaccination faces numerous barriers. One of the main problems is the inaccessibility of timely vaccination of new-borns in low- and middle-income countries due to lack of resources, logistical difficulties and insufficient awareness of healthcare personnel and parents (Turmagambetova et al., 2017; Bogoyavlenskiy et al., 2023a). Studies show that the key factors that hinder vaccination coverage are vaccine bias, lack of knowledge among mothers, and limited access to health facilities, especially for home births (Freeland et al., 2023). In Kyrgyzstan, access to vaccination also faces a number of specific challenges. Economic barriers, limited neonatal vaccination coverage in some regions, and the lack of regular immunization programmes contribute to the fact that some population remains vulnerable to infection. In addition, restrictions on the dissemination of information about the importance of vaccination significantly affect its implementation among the most vulnerable groups.

Improving the effectiveness of HBV vaccination in Kyrgyzstan requires a comprehensive approach based on the WHO recommendations and taking into account the specifics of the local context. First and foremost, it is necessary to expand vaccination coverage among the adult population, including through the introduction of vaccination programmes in workplaces, educational institutions and prisons. It is also important to ensure that vaccination is accessible to vulnerable groups, such as migrants and people who inject drugs. For this purpose, it is advisable to consider the use of mobile teams and vaccination points. Strengthening outreach efforts to raise public awareness about hepatitis B and the importance of vaccination is critical. Different communication channels should be used, adapting messages to target audiences. Integrating hepatitis B vaccination into existing health programmes, such as tuberculosis and HIV programmes, can help optimize resources and increase prevention effectiveness. Implementation of these recommendations in Kyrgyzstan is justified by the high level of migration, prevalence of chronic hepatitis B and limited access to health services in some regions, which pose significant public health challenges.

Assessment of coverage and factors influencing hepatitis B vaccination in Jalal-Abad

Hepatitis B virus remains a serious public health problem worldwide, and Kyrgyzstan is no exception. Despite the availability of an effective vaccine, many countries face difficulties in achieving high vaccination

Table 1: Rapid HBV test for the adult population by GFD and FMC of Jalal-Abad city for 2023

GFD	Total population	From 18 years and older	Had the rapid HBV test	HBsAg-negative	HBsAg-positive
			abs.n	abs.n	abs.n
No. 1	18048	10261	265	254	11
No. 2	21414	12919	317	307	10
No. 3	18808	11303	276	256	20
No. 4	22820	15100	290	288	2
No. 5	15630	9019	244	238	6
No. 6	3583	1847	193	186	7
No. 7	10059	5581	241	236	5
No. 8	5212	2911	140	136	4
No. 9	4354	2366	160	155	5
Overall, according to the FMC	119928	71307	2126	2056	70

HBV – hepatitis B virus; GFD – groups of family doctors; FMC – Family Medicine Center; abs.n – absolute number

Source: created by the authors

coverage, especially among the adult population. Successful vaccination depends on a number of factors, including access to healthcare services, public awareness and the effectiveness of information campaigns. In 2023, the city of Jalal-Abad conducted a population survey for hepatitis B virus using rapid tests, and the data obtained during this survey are shown in Table 1. Thus, the low level of testing coverage may be due to various factors, including limited access to healthcare services, lack of awareness of the importance of HBV screening, and possible logistical difficulties.

As shown in Table 1, of the 2,126 individuals tested, 96.7% were negative for HBsAg, indicating no active HBV infection. 3.3% were found to be positive for HBsAg, requiring further examination and medical follow-up to determine the stage and nature of the infection (acute or chronic). HBV vaccination coverage in Jalal-Abad also remains low, at only 2.9%. This indicates the need to strengthen immunization activities, including public awareness and ensuring the availability of vaccines.

The analysis of testing coverage in different city's GFDs shows significant variability. The highest coverage rates were observed in the GFD No. 6 (10.4%) and the GFD No. 9 (6.7%). In the other GFDs, testing coverage was much lower, ranging from 1.5% (GFD No. 1) to 4.8% (GFD No. 8). Such differences may be related to the different levels of organization of healthcare facilities, the activity of medical staff, as well as the socio-economic characteristics of the population served by different GFDs. Since October 2023, due to interruptions in the supply of rapid tests, the laboratory of the Oblast AIDS Centre has started using ELISA for HBV diagnosis. A total of 2,126 people were tested using the ELISA method.

The collection of epidemiological history from HBV-positive individuals allowed us to identify possible routes of infection. These data are presented in Table 2.

The data analysis showed that the most frequent infections occurred in dental facilities (25.7%). This indicates the need to strengthen control over

Table 2: Distribution of HBV-positive individuals by probable routes of infection in the FMC of Jalal-Abad for 2023 (number of individuals)

Name	Total positives	Treatment in medical and preventive institution	Treatment at the dentist	Contact with viral hepatitis	Unknown
Overall, according to the FMC	70	10	18	10	32

HBV – hepatitis B virus; FMC – Family Medicine Center

Source: created by the authors

compliance with sanitary and epidemiological standards in these facilities, in particular, sterilization of instruments and use of disposable materials. The second most common route of infection was treatment in medical and preventive institution (14.3%), which also indicates the need to improve infection control in healthcare facilities. Contact in family units with previous HBV cases also accounted for 14.3%. This underscores the importance of preventive measures among family members of HBV-infected persons, including vaccination. In a significant proportion of cases (45.7%), the route of HBV transmission could not be established. This may be due to the presence of hidden routes of transmission, as well as difficulties in retrospective identification of the source of infection.

The coverage of hepatitis B testing and vaccination among the adult population in the GFD of Jalal-Abad is extremely low (3.0%). There is a need to increase public awareness of HBV testing with rapid tests and the importance of HBV vaccination through the media. The low uptake of vaccination and insufficient mobilization of healthcare workers in conducting information activities may lead to an extended need for such measures in the city for a long period of time, possibly up to 20 years, which may complicate the epidemiological situation with regard to the incidence of hepatitis B virus in the city and in the region.

Study of the number of people who decided to get vaccinated during 2023

The dynamics of visits to vaccination points throughout the year shows an alarming downward trend. At the beginning of the campaign, in January, the frequency of visits was 5.4 people, while in December this figure dropped to 0.07 people per day. Such a sharp drop in the frequency of referrals over the course of the year indicates the ineffectiveness of the vaccination strategy.

There was a significant variation in the average daily frequency of visits between different GFDs. While in some GFDs (e.g., GFD No. 1 – 1.1 persons per

day, GFD No. 3 – 1.5 persons per day), the rates were relatively higher, in GFDs No. 9 and No. 6, they were critically low – 0.07 and 0.1 persons per day, respectively. These disparities may be related to the uneven distribution of resources, different levels of public awareness and access to healthcare services. The low effectiveness of the HBV vaccination campaign may be due to a number of factors, including the voluntary nature of vaccination, insufficient health education, which has led to low levels of public awareness of HBV risks and the importance of prevention, and possible organizational problems in the health care system. Thus, to improve the situation, a comprehensive strategy should be developed and implemented to increase the coverage of both HBV testing and vaccination.

The current study also recorded the number of people who decided to be vaccinated in 2023. These data are presented in Table 3. This allowed us to assess not only the final results of the vaccination campaign, but also to analyse the dynamics of vaccination decision-making throughout the year.

In 2023, the highest rate of HBV vaccination (first, second, and third doses) in the family medicine centre of Jalal-Abad was observed in the age group 50–59 years (63.4, 62.1 and 55.6 per 1,000 population, respectively). The second place is occupied by the 40–49 age group (51.4, 50.3 and 42.8 per 1,000 population). The third-highest vaccination rate is in the 30–39 age group (41.6, 35.8, and 32.1 per 1,000 population). The lowest vaccination rate in the FMC is observed among people aged 18–29 years (13.4, 12.6, and 9.7 per 1,000 population). These data indicate greater awareness of HBV risks among the older generation, the presence of chronic diseases that increase the risk of hepatitis complications, and greater activity in seeking care. In turn, low rates among young people indicate the need to strengthen awareness-raising among young people about the importance of HBV vaccination and its role in preventing the development of chronic hepatitis and its complications. Low vaccination coverage among

Table 3: Population that received three doses of HBV vaccination by age category in the FMC

FMC	Age/years					Total persons
	18–29	30–39	40–49	50–59	60>	
	n	n	n	n	n	
No. 1	315	719	631	534	284	2483
No. 2	298	618	616	523	280	2335
No. 3	228	555	526	468	244	2021

HBV – hepatitis B virus; FMC – Family Medicine Center; n – the absolute number of vaccinated people in each age group; No. 1 – the first dose of vaccine; No. 2 – the second dose of vaccine; No. 3 – the third dose of vaccine

Source: created by the authors

Table 4: Population that received the first dose of HBV vaccine by age category in GFD and FMC of Jalal-Abad city in 2023 (per 1,000 population)

GFD	Age/years										Total
	18–29		30–39		40–49		50–59		60>		
	n	i.i.	n	i.i.	n	i.i.	n	i.i.	n	i.i.	
No. 1	27	11.6	102	37.7	69	41.6	62	50.1	39	24.4	29.1
No. 2	35	10.9	91	26.1	88	33.0	66	34.6	56	33.4	26.0
No. 3	55	19.2	126	44.2	86	42.7	67	47.3	27	17.5	31.9
No. 4	59	22.9	83	25.8	69	23.4	60	26.0	38	13.4	20.4
No. 5	42	22.4	103	41.0	92	60.5	84	69.9	29	25.8	38.8
No. 6	31	7.3	59	12.0	72	19.6	51	255	33	17.5	133.2
No. 7	38	30.1	64	42.8	71	73.4	69	100.0	36	46.9	49.8
No. 8	5	7.8	39	49.5	38	77.1	41	121.3	12	27.7	46.4
No. 9	23	44.1	51	91.3	46	79.5	34	87.4	14	132.0	71.0
Overall, according to the FMC	315	13.4	719	41.6	631	51.4	534	63.4	284	30.3	36.0

HBV – hepatitis B virus; GFD – groups of family doctors; FMC – Family Medicine Center; n – the absolute number of individuals who received the first dose of HBV vaccine in the corresponding age group; i.i. – an intensive indicator that shows the number of individuals who received the first dose of HBV vaccine per 1,000 population of the corresponding age group

Source: created by the authors based on reports submitted by GFD No. 1–9

young people creates prerequisites for further spread of HBV and increase in morbidity in the future (Bogoyavlenskiy et al., 2023b; Suleiman et al., 2023).

As for the distribution of data on GFD (Table 4), the data were as follows: during the year, 2,483 people applied to the FMC of Jalal-Abad for the first vaccination, which is a frequency of application of 36.0 per 1,000 population. Among the groups of family doctors, a high frequency of referrals for vaccination when receiving the first dose was observed in the GFD No. 6, and the lowest frequency of referrals for vaccination was noted in the territory of the GFD No. 4.

According to the city's FMC, the highest frequency of vaccination seeking during the first dose was in the 50–59 age group. In the territories of family physician groups, a high frequency of vaccination seeking was observed in the GFD No. 8 and GFD No. 7. The second-highest rate in the city's FMC was in the age group 40–49 years. Among the groups of family doctors, the second place in this age group was taken by GFD No. 9, No. 8 and GFD No. 7. The third place in the FMC was occupied by the age group 30–39 years, and the highest vaccination frequency was observed in the territory of the GFD No. 9. The lowest frequency of vaccination according to the FMC was in the 20–29 age group, and the lowest vaccination uptake in this age group was observed in the territories of GFDs No. 6 and No. 8.

The fourth-highest vaccination uptake was in the age group 60 years and older, and the highest vaccination

frequency in this age group was observed in the territory of GFD No. 9. According to the data of the GFD, 18–19-year-olds were vaccinated with the first dose only in GFD No. 4 and GFD No. 9, while in the rest of the GFD and in the city's FMC there were no requests for vaccination in this age group.

HBV vaccination data indicate uneven coverage of different demographic groups. There is a clear correlation between age and vaccination seeking, with the highest rates in older age groups and the lowest among young people, indicating the need for targeted work with young people to raise awareness of HBV risks and the importance of vaccination. Significant differences in rates between different GFDs point to the need to analyse the factors that contribute to this inequality and develop measures to address it. This may include improving access to vaccination, improving the skills of medical staff, and strengthening public awareness. Overall, low HBV vaccination coverage requires a comprehensive approach to improve the situation and prevent the spread of infection.

Among the population, a high frequency of vaccination with the second and third doses was also observed in these age groups in the territory of the GFD No. 6–9. After the first vaccination, 94% received the second dose 30 days later, while 6% did not receive the second dose. By age, the highest coverage with the second dose of vaccination was observed in the age group 60 years and older (98.5%), while the lowest coverage with the second dose was in the

Table 5: Distribution of people vaccinated against HBV by gender and dose in the FMC of Jalal-Abad for 2023 (number of people)

Sex	First dose	Second dose	Third dose	Average value
Male	755	762	665	727
Female	1728	1573	1356	1552

HBV – hepatitis B virus; FMC – Family Medicine Center
Source: created by the authors

age group 30–39 years (82.5%). The third vaccination is given 5 months after the second. The third vaccination was received by 2,021 people (86.5%), while 314 people (13.5%) were not vaccinated. By age, high coverage with the third dose of vaccination was observed in the age groups 50–59 years (89.2%) and 30–39 years (89.4%), while the lowest coverage with the third dose was in the age group 20–29 years (75.8%).

The current study also assessed the distribution of the number of people vaccinated with three doses by gender. The data are presented in Table 5.

Analysis of the sex distribution of those vaccinated against HBV in the FMC of the city of Jalal-Abad in 2023, given the data in Table 4, shows a statistically significant difference in vaccination coverage between men and women. The overall proportion of women who received HBV vaccination is 68.1%, while for men this figure is much lower – 31.9%. A closer look at the distribution by vaccination dose confirms this trend. Among those who received the first dose of the vaccine, women account for 69.6% and men for 30.4%. A similar situation is observed for the second (67.4% of women vs. 32.6% of men) and third (67.1% of women vs. 32.9% of men) doses of the vaccine.

The observed difference in vaccination rates between the sexes may be due to a number of social, cultural and behavioural factors. In particular, women are more likely to visit healthcare facilities for preventive care and are more attentive to doctors' recommendations for vaccination. In addition, women may be better informed about the risks associated with HBV and the importance of timely vaccination. On the other hand, men may show less concern for their own health and underestimate the need for preventive measures, including vaccination. The identified disparity in vaccination coverage between the sexes indicates the need to develop targeted information campaigns aimed at raising awareness of the importance of HBV vaccination among men and motivating them to participate more actively in prevention programmes. This will help to reduce the gap in vaccination rates between the sexes and ensure

more effective protection of the population from HBV infection.

Analysis of the social status of persons seeking HBV vaccination in the FMC of Jalal-Abad in 2023 shows a heterogeneous distribution of vaccination coverage among different professional and social groups. The largest proportion of vaccinated persons are non-working citizens (52.7, 52.4 and 52.9% of applications for the first, second and third doses, respectively). Particularly high rates of referrals among non-working people are observed in the GFD No. 7 (64.1%) and No. 5 (75.8%). This may be due to the specific demographic composition and socio-economic characteristics of the population served by these facilities. Perhaps, in these districts, a higher proportion of unemployed people have more free time to visit healthcare facilities, or there are more elderly people who are more likely to be vaccinated.

The second-largest group is healthcare workers (11.5, 11.6, and 12.4% of visits for each dose, respectively). The highest vaccination rates among healthcare workers were recorded in GFD No. 1 (20.4%), No. 4 (17.1%) and No. 8 (14.1%). This may indicate that healthcare workers are better informed about the risks of HBV infection and the importance of vaccination, as well as the possible existence of internal recommendations or requirements for vaccination of staff in these facilities. Employees of educational institutions make up the third-largest group (10.3 and 9.6% of applications for the first and second doses, respectively). The highest rates in this category were observed in the GFD No. 6 (22.4%) and GFD No. 4 (17.5%).

The lowest frequency of vaccination visits was recorded among students (0.3–1.4%) and service workers (0.7–0.8%). This may be due to a low level of awareness of HBV infection risks among these groups, lack of time or opportunities for vaccination, and certain behavioural factors. The remaining categories of the population demonstrate a rate of seeking treatment ranging from 1.3 to 7.8%. The uneven distribution of HBV vaccination coverage among different social groups indicates the need for a differentiated approach to outreach and vaccination campaigns, taking into account the specifics of each target group.

Discussion

The study of hepatitis B vaccination among the adult population of Jalal-Abad (Kyrgyz Republic) showed results that reflect current problems in the organization of preventive measures and ways to solve them. Firstly, the low vaccination coverage (3%)

indicates the insufficient effectiveness of existing vaccination programmes and the need to adjust the strategy.

In Beijing, Liang et al. (2021) reported a vaccination coverage of 31.3%, which, although inadequate for herd immunity, is tenfold greater than the level observed in Jalal-Abad. Both studies indicated awareness and socioeconomic status as critical drivers of vaccine uptake. The current findings highlight two significant aspects: structural obstacles, including disruptions in test supply and variations in performance within family doctor groups, as well as notably low participation rates among young individuals (ages 18–29). The disparities suggest that in Kyrgyzstan, constrained resources and ineffective information efforts exacerbate each other, leading to both insufficient overall coverage and age-specific deficiencies.

Sanai et al. (2020) have shown, through an economic impact tool, that extensive HBV vaccination and treatment initiatives could significantly reduce disease burden and yield long-term cost savings, contingent upon sufficiently high coverage rates. Conversely, the circumstances in Jalal-Abad indicate that the anticipated economic and epidemiological advantages are improbable to materialise in the near future, owing to minimal engagement in testing and immunisation, logistical limitations, and inadequate public awareness. The two studies converge in emphasising the pivotal role of vaccination in HBV elimination strategies: both affirm that enhancing vaccination uptake is crucial for diminishing morbidity and mortality. However, the Saudi model forecasts the potential outcomes of effective implementation, while the Jalal-Abad data demonstrate the repercussions of insufficient coverage in practice.

Chen (2018) underscored that the worldwide eradication of hepatitis B is contingent more upon robust health-system capability, financial resources, and access to care than on vaccine efficacy. The Jalal-Abad data robustly corroborate this conclusion. Notwithstanding the shown efficacy of the vaccination, the lack of dependable infrastructure, logistical consistency, and sustained informational campaigns hinders significant advancement. This emphasises that elimination programmes in resource-constrained nations must prioritise the enhancement of delivery systems prior to achieving population-level objectives.

Bridges et al. (2019) demonstrated that vaccine completion rates among high-risk persons in the United States varied markedly by clinic type, with community health centres yielding superior outcomes compared to sexually transmitted disease clinics. This mirrors the present study, in which immunisation rates varied significantly within family doctor groups within

the same city. Both instances illustrate that the micro-level organisation of healthcare delivery, encompassing recall systems, follow-up mechanisms, and staff engagement, directly impacts completion rates.

Trevisan et al. (2020) established that women frequently have more robust immune responses to hepatitis B vaccinations compared to men. The current research did not assess antibody levels, but the majority of vaccinated individuals being women (68.1%) indicates that gender disparities encompass not only biological factors but also health-seeking behaviours. Women in Jalal-Abad are more inclined to utilise healthcare services and adhere to medical advice, whereas men may undervalue the significance of preventive measures. These findings underscore the necessity for focused initiatives promoting male participation in immunisation.

Lu et al. (2021) documented suboptimal immunisation rates among US individuals with diabetes, despite explicit medical guidelines. In Jalal-Abad, young adults exhibited the lowest vaccination rates among all age demographics, despite regular interactions with health and educational institutions. Both instances demonstrate that affiliation with a risk group or access to the healthcare system does not inherently result in elevated vaccination rates. Targeted interventions, including opportunistic vaccination during routine visits and awareness campaigns for kids, are essential to address these gaps.

Investigation by Yendewa et al. (2023) indicated that obstacles to access, including considerable distances to healthcare facilities, insufficient antenatal care, and elevated home birth rates, reduced childhood immunization coverage to a range of 40 to 70%. While the study concentrated on children, the pattern mirrors that of Jalal-Abad. Challenges in service accessibility and inequitable resource distribution correlate with low vaccination rates. This indicates that structural impediments in service delivery significantly impact both childhood and adult immunization.

The global assessment by Al-Busafi and Alwassief (2024) highlighted that the eradication of hepatitis B necessitates not only efficacious vaccines but also public education, integration with other health services, and procedures that guarantee patients receive all doses. The findings from the present analysis reveal deficiencies in all these domains: insufficient public awareness, inadequate integration with current programs, and subpar completion rates. This underscores the necessity for integrated strategies, education, integration, and dependable follow-up systems.

The current study found low hepatitis B vaccination coverage among the adult population of Jalal-Abad,

which was only 3% in 2023. The lowest rates were observed among young people, where coverage was 13.4, 12.6 and 9.7 per 1,000 people, while older age groups had significantly higher vaccination rates (63.4, 62.1 and 55.6 per 1,000 people). The main barriers were limited access to healthcare services, lack of awareness among the population, and lack of effective information campaigns. These factors contribute to the uneven coverage among demographic groups and the low overall effectiveness of the vaccination campaign.

A factor influencing vaccination uptake is vaccine hesitancy, characterised by scepticism towards vaccines, apprehension regarding possible side effects, and the impact of disinformation. This is particularly pertinent for younger demographics, who exhibited the lowest immunisation rates in the current study. The diminished demand for vaccination among the 18–29 demographic may indicate not just organisational constraints but also a hesitance to recognise hepatitis B as a significant hazard. Comparable results have been observed in several contexts, where decreased perceived vulnerability, the dissemination of misinformation via internet platforms, and scepticism about medical authorities have markedly hindered vaccination rates (Jaffe et al., 2022). Confronting these attitudinal obstacles necessitates targeted educational initiatives, customised communication tactics, and trust-enhancing measures between healthcare providers and young adults.

In the WHO European Region, advancements have primarily resulted from robust baby immunization programs, with vaccine coverage approximating 91%, according to Khetsuriani et al. (2021). Conversely, Kyrgyzstan concentrated on adult immunization in Jalal-Abad. Yet, coverage remained alarmingly low, particularly among the youth. The study indicates that countries prioritizing baby vaccination have been more effective in managing hepatitis B, while adult-focused programs require supplementary support measures to achieve efficacy.

Liu et al. (2019) indicated that China's progress towards hepatitis B elimination is founded on a multifaceted strategy that integrates newborn vaccination, prevention of mother-to-child transmission, and vaccination of high-risk adults. In contrast, Jalal-Abad has not yet adopted such methodologies. The inadequate participation of young adults and restricted coverage of at-risk populations highlight the necessity to modify aspects of China's policy, including opportunistic vaccination at routine health appointments and enhanced oversight of program efficacy.

Nurmanova (2024) revealed that Central Asia has experienced inconsistent advancement in the

elimination of viral hepatitis at the regional level, facing prevalent problems such as unstable funding and inadequate data collection. The obtained data above corroborate this scenario at the local level: immunization rates are markedly low, reporting is inadequate, and program implementation is variable between facilities. This substantiates the assertion that Kyrgyzstan needs enhanced data systems and a reliable vaccine supply to augment coverage.

The hepatitis B vaccination must be evaluated within the broader public health framework of Kyrgyzstan, where tuberculosis, HIV/AIDS, and the repercussions of the COVID-19 pandemic compete for few healthcare resources. These situations encompass overlapping risk populations, including individuals who inject drugs, imprisoned persons, and migrants. Incorporating the hepatitis B vaccine into current HIV and tuberculosis programs could enhance resource efficiency, refine preventative tactics, and guarantee continuity of treatment. On the contrary, competition for financial and human resources may engender conflicts that restrict service provision. Identifying these synergies and potential conflicts is crucial for formulating sustainable immunization policies that correspond with national health priorities.

The study revealed low HBV vaccination coverage in Jalal-Abad, which is due to limited access to healthcare services, lack of public awareness and ineffective information campaigns. Young people have particularly low vaccination rates, while older age groups show higher coverage. An uneven distribution of vaccination coverage was also recorded between different groups of family doctors. Gender differences have been identified: women are vaccinated more often than men. Comparison with other studies indicates similar problems in different countries and regions related to access to healthcare services, awareness, and effectiveness of vaccination campaigns. The experience of other countries demonstrates the importance of a comprehensive approach to vaccination, including access to vaccines, targeted information campaigns, and consideration of the sociodemographic characteristics of the population. The results of the study highlight the need to develop and implement an effective HBV vaccination strategy in Jalal-Abad aimed at increasing vaccination coverage and reducing the risk of disease spread.

Conclusion

A study of HBV vaccination among the adult population of Jalal-Abad showed a low vaccination coverage rate of only 3% in 2023. Out of 71,307 adult residents of the city, only 2,126 people (3%)

were tested for HBsAg, of whom 70 people (3.3%) were positive, requiring further examination. Among the 2,483 people who received the first dose of the vaccine, only 2,21 people (86.5%) completed the three-dose course, while 462 people (13.5%) did not receive all doses.

An analysis of vaccination by age group showed that the highest rates were in the age groups 50–59 years (63.4 per 1,000 population) and 40–49 years (51.4 per 1,000 population). The lowest rates were recorded among young people aged 18–29 years – 13.4, 12.6 and 9.7 per 1,000 population for the first, second and third doses, respectively. The gender distribution showed that women accounted for 68.1% of those vaccinated, while men accounted for only 31.9%.

The variability in vaccination coverage among family physician groups is also significant: No. 6, the proportion of those vaccinated with the first dose reached 133.2 per 1,000 population, while in group of family doctors No. 4, this figure was only 20.4 per 1,000 population. The highest vaccination rates were observed among non-workers (52.7%), healthcare workers (11.5%) and educators (10.3%), while coverage among students (0.3–1.4%) and service workers (0.7–0.8%) remained minimal.

The low vaccination coverage is due to both organizational and behavioural factors: lack of vaccines during certain periods, insufficient health education and logistical difficulties, particularly in remote areas. These obstacles require large-scale measures to improve vaccine availability, including the establishment of mobile vaccination units and targeted campaigns to reach young people and socially vulnerable groups. Poor quality of reporting and uneven coverage among family doctors limits the accuracy of the study results. Further research could be conducted to study the effectiveness of information campaigns and the introduction of mobile vaccination units.

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