Human Metapneumovirus: Modern Challenges for Medicine and Pharmaceutics

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Received: March 05, 2025
Published: April 01, 2025

Abstract. The article analyzes the epidemiological characteristics of Human metapneumovirus, its role in the structure of respiratory diseases, possible complications, and socio-economic consequences for society. Special attention is paid to the prospects for integrating preventive measures against Human metapneumovirus into national immunization programs, as well as the challenges facing medicine and pharmacy in the context of developing vaccines and therapeutic approaches to treating the infection. The article is devoted to the analysis of modern challenges associated with the spread of Human metapneumovirus, its impact on the healthcare sector, medicine, and pharmacy. Human metapneumovirus is a significant respiratory pathogen that causes upper and lower respiratory tract infections, especially among children, the elderly, and people with weakened immune systems. The article examines the epidemiological characteristics of Human metapneumovirus, its seasonality, and the problems of diagnosing and preventing the infection. Special attention is paid to the role of Human metapneumovirus in the structure of respiratory diseases and the need to integrate preventive measures against this virus into national vaccination programs. The article analyzes the current changes to the national vaccination schedule in Ukraine, proposed by the Ministry of Health, as well as their potential impact on reducing the incidence of respiratory infections. The current challenges for pharmaceuticals related to the development of vaccines and therapeutics against Human metapneumovirus, as well as the socio-economic aspects of combating the infection, are discussed. The article emphasizes the importance of an interdisciplinary approach to solving the problem of Human metapneumovirus, which includes cooperation between epidemiologists, physicians, pharmacists, and representatives of state bodies.

Keywords: Human metapneumovirus, respiratory infections, medicine, pharmaceutics, vaccination, prevention.

Introduction. In modern conditions in the countries of the world, in Ukraine, acute respiratory viral infections are one of the most common causes of morbidity, disability and mortality among all segments of the population. Only in 2000, acute respiratory viral infections worldwide were the cause of approximately 20% of total deaths in children under 5 years of age [1].

Seasonal manifestations of acute respiratory viral infections, influenza, covid, post-covid, long-covid, comorbid, chronic disorders cause suffering in different age groups of the population every year [2-4].

As established, Human metapneumovirus is one of the most common viruses. It is in the center of children and elderly adults, patients with weakened immune systems, diseases of the circulatory system, acute respiratory viral infections, community-acquired pneumonia, monkeypox virus, psychoneurological, cardiovascular disorders in accordance with ICD-11 [5-7].

WHO emphasizes the importance of preparing for the winter season due to the circulation of respiratory viruses. Respiratory infections can pose a serious threat to risk groups. Up to 72,000 people die from influenza in Europe every year. The COVID-19 pandemic has taught the world the value of vaccination, hygiene, and other preventive measures. However, the collective amnesia about this virus is worrying, as it is still circulating. The experience of fighting COVID-19, influenza and emerging pathogens highlights the importance of continuous monitoring, strengthening health systems and investing in primary care, especially given the shortage of personnel and limited resources. It is necessary to adhere to preventive measures (vaccination, wearing masks, hygiene, ventilation), focus on protecting vulnerable groups (elderly people, pregnant women, patients with weakened immunity). The collective responsibility of governments, authorities, and society in creating a culture of care and solidarity is necessary to minimize the harm from new and existing pathogens to health, the economy and society [8]. In Ukraine, children account for more than half of acute respiratory viral infections. In December 2024, the incidence decreased by 16.8% compared to

the same period. Among children - by 19.7%. During this period, 344 cases of COVID-19 were confirmed, including four deaths among unvaccinated individuals [9]. Human metapneumovirus belongs to the Pneumoviridae family. It was discovered in 2001. It has been present as a common respiratory pathogen for over 60 years. Human metapneumovirus is transmitted through droplets or aerosols during coughing and sneezing. The incubation period is 3-5 days. The infection manifests with cold-like symptoms (cough, fever, nasal congestion). In severe cases, it can lead to bronchitis or pneumonia, especially among children, the elderly, and those with weakened immune systems. According to the Lancet Global Health, Human metapneumovirus causes 1% of deaths associated with acute lower respiratory tract infections in children under 5 years of age. In China, its incidence is 4.1%, which is significantly lower than influenza (28.5%). Prevention includes wearing masks, washing hands, airing rooms, and avoiding contact with sick people. There is currently no vaccine or specific treatment; therapy is focused on relieving symptoms [10].

The purpose of the study was to research the current challenges associated with the spread of Human metapneumovirus, its impact on the healthcare system, pharmaceuticals. As well as to assess the effectiveness of preventive measures, in particular vaccination.

Materials and methods. The research presented in this article is based on a multifaceted approach to the analysis of current challenges associated with Human metapneumovirus infection, its impact on the healthcare sector and pharmaceuticals. Research period: November 2024 - March 2025.

To achieve the goal, the task was set, the materials and research methods were used (Table 1)

Table 1. Tasks, materials, research methods.

Task	Materials, methods
1. Analysis of scientific literature and epidemiological data	○ Review of scientific publications, including articles, monographs, and clinical studies, was conducted regarding the spread of Human metapneumovirus, its epidemiological characteristics, symptoms, and complications. ○ Data from international organizations such as WHO, CDC, and Ukrainian public health centers were used to analyze the prevalence of Human metapneumovirus in the world and in Ukraine.
2. Documentary analysis	○ Regulatory and legal acts were studied, the draft order of the Ministry of Health of Ukraine on changes to the National Calendar of Preventive Vaccinations. ○ The recommendations of national and international experts on the issues were analyzed immunoprophylaxis, regarding the integration of vaccines against HMPV into existing programs.
3. Epidemiological analysis	○ Epidemiological indicators such as the frequency of infections, the level of complications and hospitalizations associated with Human metapneumovirus were used. ○ Seasonality of the incidence of Human metapneumovirus and its co-circulation with other respiratory viruses (influenza, acute respiratory viral infections, RSV, COVID-19) were assessed.
4. Quantitative and qualitative analysis	○ Analysis of vaccination rates among the population of Ukraine was conducted to identify possible barriers to the introduction of new vaccines, against Human metapneumovirus. ○ Effectiveness of existing preventive measures (hygiene, self-isolation, ventilation of premises) and their role in preventing the spread of infection was assessed.

5. Comparative analysis methods	○ Data on preventive measures against Human metapneumovirus were compared with similar approaches to combat other respiratory viruses. ○ Experience of other countries in implementing vaccines and treatment strategies against Human metapneumovirus was evaluated.
6. Sociological aspect	○ Opinions of the public, healthcare professionals, and the scientific community on the need to develop and implement vaccines against Human metapneumovirus were studied through the analysis of materials from public discussions.
7. Pharmaceutical analysis	○ Review of the status of vaccine and therapeutic development against Human metapneumovirus was conducted, including studies of the efficacy of experimental vaccines and antiviral drugs. ○ Role of the pharmaceutical industry in ensuring an effective response to the challenges associated with the spread of Human metapneumovirus was assessed.

The study is based on a comprehensive approach, including an analysis of literature, regulatory documents, epidemiological data, and sociological aspects. This allows for a detailed assessment of the challenges facing the healthcare and pharmaceutical sectors, as well as the development of recommendations for improving the system of immunoprophylaxis against Human metapneumovirus.

The research of the article is a fragment of research works of Private Scientific Institution "Scientific and Research University of Medical and Pharmaceutical Law" on the topics "Multidisciplinary research of post-traumatic stress disorders during war among patients (primarily combatants)" (state registration number 0124U002540, implementation period 2024-2029), and "Interdisciplinary scientific and methodological research in the field of pharmaceuticals and veterinary medicine: innovations, modernization, technologies, regulation" (state registration number 0125U000598, implementation period 2025-2031), and "Diagnosis, treatment, pharmacotherapy of inflammatory, traumatic and onco-thoracic pathology using instrumental methods" (state registration number 0125U000071, implementation period 2025-2031); Lviv Medical Institute on the topic of "Improving the system of circulation of drugs during pharmacotherapy on the basis of evidentiary and forensic pharmacy, organization, technology, biopharmacy and pharmaceutical law" (state registration number 0120U105348, implementation period 2021-2026).

Results and discussion. Human metapneumovirus is a respiratory disease. It causes symptoms like a cold or flu, but can cause serious complications such as bronchitis or pneumonia, especially among the elderly, young children, and people with weakened immune systems. The recent increase in cases in northern China, especially among children, has caused concern. But experts assure that the situation is under control. The increase in incidence is explained by new diagnostic methods and increased caution after the COVID-19 pandemic. Human metapneumovirus is not a new virus and has been circulating for several decades. Therefore, the risk of a new pandemic is considered low. There is no vaccine or specific treatment yet. Therefore, prevention is based on hygiene measures: wearing masks, washing hands, avoiding contact with sick people and observing cough etiquette. Human metapneumovirus can be dangerous for vulnerable groups of the population. In general, Human metapneumovirus does not have pandemic potential. The focus is on reducing its spread [11].

An outbreak of Human metapneumovirus has been recorded in China. It is accompanied by overcrowded hospitals due to other respiratory infections, including influenza and COVID-19. Although Human metapneumovirus can be a cause for concern, the overall risk remains manageable. In India, two cases of Human metapneumovirus have been confirmed in Bengaluru: an eight-month-old child is currently being treated in hospital, and a three-month-old has already been discharged.

The main features of Human metapneumovirus are shown in Fig. 1.

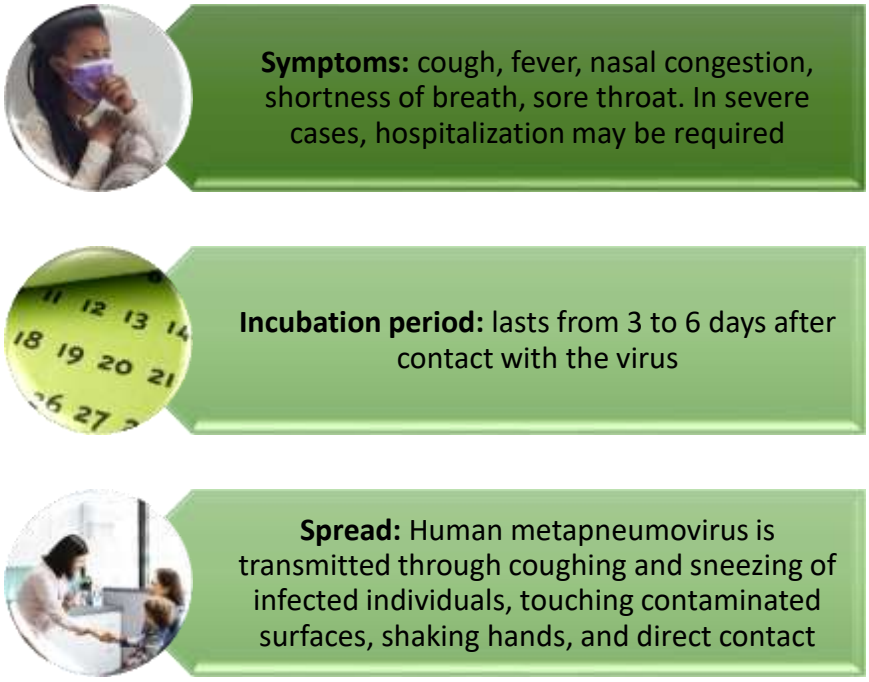

Fig. 1. Main characteristics of Human metapneumovirus

The risk groups are given in Fig. 2.

Fig. 2. Risk groups for Human metapneumovirus.

Symptoms, complications, vaccination, treatment of Human metapneumovirus are shown in Fig. 3.

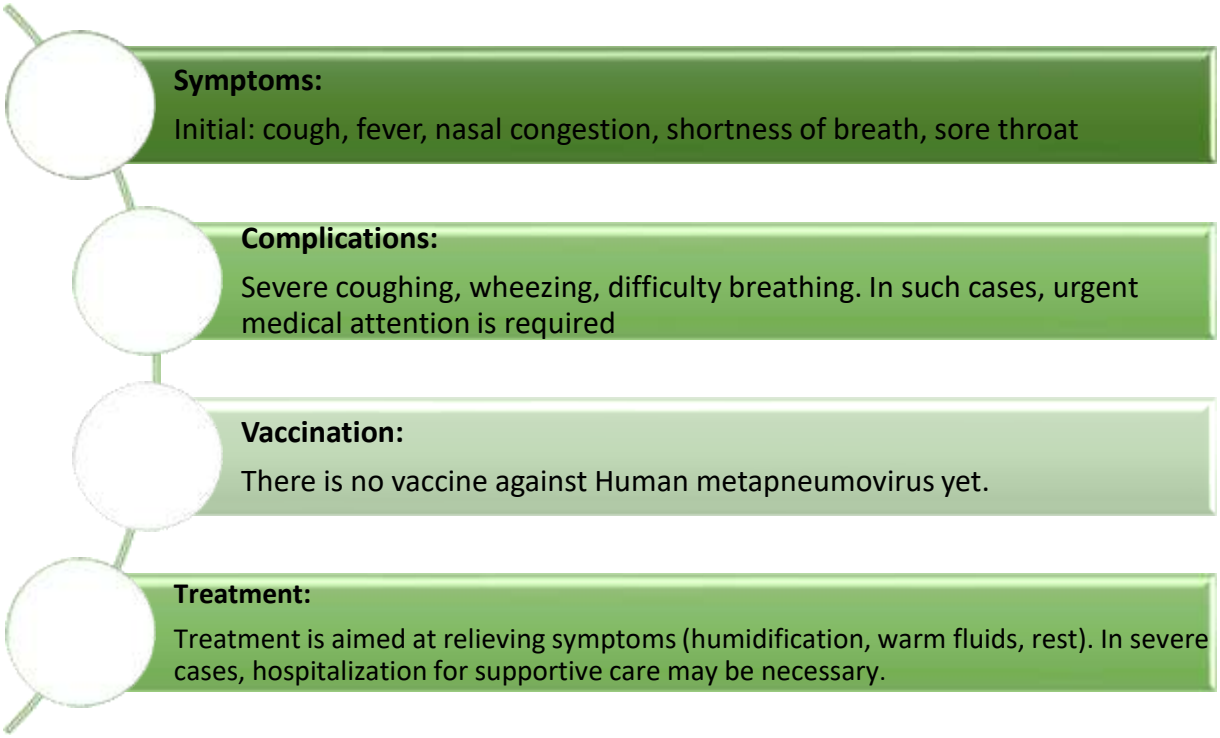

Fig. 3. Clinical features of Human metapneumovirus.

How to distinguish Human metapneumovirus from a cold?

- Common cold: symptoms are milder and resolve more quickly.
- Human metapneumovirus: symptoms can be similar, but the infection often affects people who are new to the virus or those who are immunocompromised.

Tips for preventing Human metapneumovirus are shown in Fig. 4.

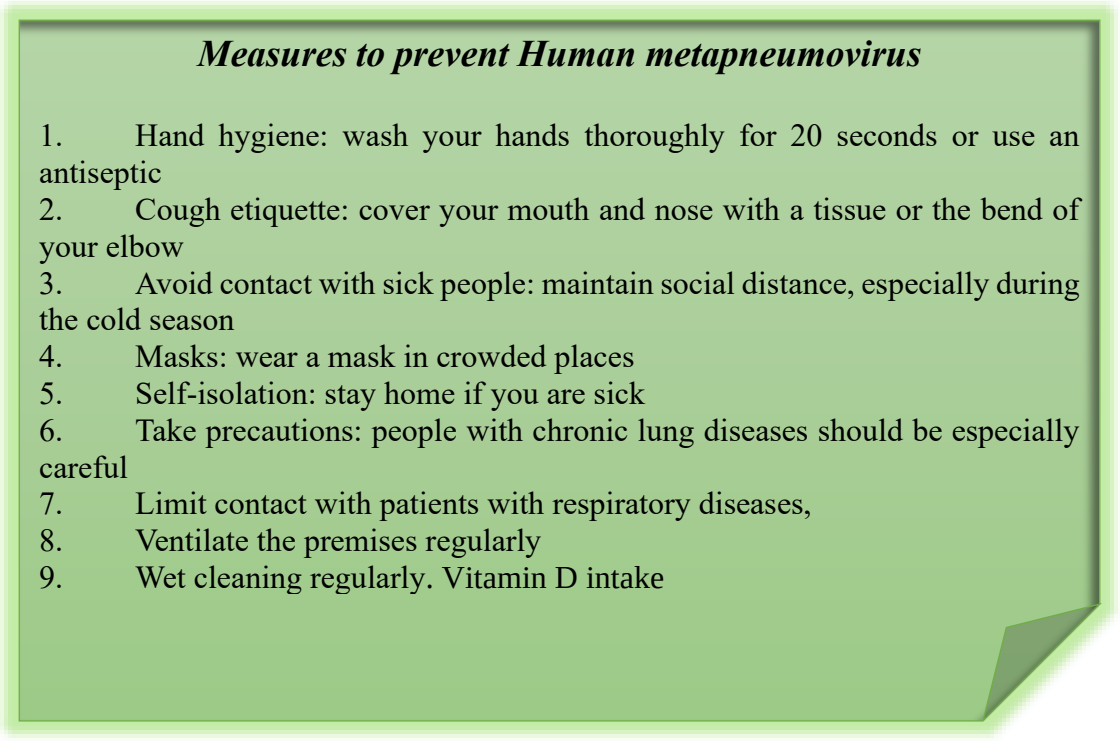

Fig. 4. Measures for the prevention of Human metapneumovirus (Warning. Information about Human metapneumovirus is for informational purposes only. For accurate diagnosis and treatment, you should consult a doctor [12]).

Risks for Europe and the global context of Human metapneumovirus

The surge in cases of Human metapneumovirus in China is a cause for concern. Experts emphasize that this is a seasonal phenomenon, not a prerequisite for a new pandemic (Fig. 5).

Why is Human metapneumovirus in the spotlight?		
1. Increasing cases in the northern provinces of China, especially among children under 4 years of age, as well as recently reported cases in India	2. Seasonal respiratory infections (flu, RSV, COVID-19) are now peaking, increasing the burden on the healthcare system	3. European context: A slight increase in cases has been noted in the UK, especially among children under 5 years of age
Should Europe be worried?		
Experts believe HMPV surges are in line with normal winter trends	In the past, such infections remained unnoticed due to limited diagnostic capabilities	

Fig. 5. Why is Human metapneumovirus in the spotlight?

Differences between Human metapneumovirus and COVID-19

- Human metapneumovirus has been known for decades
- Most people have some level of immunity due to previous infections
- Human metapneumovirus is not a new zoonotic infection like COVID-19 and does not have the same pandemic potential.

Although Human metapneumovirus deserves attention because of its impact on the health of children and the elderly, the risk of its pandemic spread is extremely low. Seasonal precautions will help minimize its spread. [13].

There have been 13 officially confirmed cases of Human metapneumovirus in Ukraine. Human metapneumovirus can cause problems with both the upper and lower respiratory tract. Often with mild symptoms (runny nose, cough). In some cases, it can develop into severe complications, such as fulminant respiratory failure.

The incubation period for Human metapneumovirus is 3 to 6 days. The average duration of illness is 7 to 10 days, depending on the severity of the case. Although cases of Human metapneumovirus are often mild, it is especially important to test patients who have symptoms of respiratory illness, especially in at-risk groups or among hospitalized patients. Human metapneumovirus is a seasonal phenomenon, characteristic of late winter and spring [14].

Human metapneumovirus has also been recorded in China, Kazakhstan. Some scientists believe that Human metapneumovirus may be potentially more dangerous than COVID-19 [15].

A study of the burden of Human metapneumovirus in young children, conducted from 2003 to 2009 in the United States. Showed a significant impact of Human metapneumovirus on the health of children under 5 years of age. In a study of 3490 hospitalized children, 6% were infected with Human metapneumovirus: 7% among outpatients and 7% among children who presented to the emergency department. Infection was most common in children under 6 months of age. Children with Human metapneumovirus were found to require frequent hospitalization for pneumonia or asthma. Overall, the annual rates of hospitalization and outpatient visits associated with Human metapneumovirus were significant, indicating a significant burden of this infection, especially in the first years of life [16].

Two children infected with monkeypox virus and Human metapneumovirus have been identified in Germany. The virus was reportedly brought in by a man who had recently returned from Africa and infected his wife and two children. As a result, a school in the area was closed as a precaution. After consultation with the Robert Koch Institute, local health authorities have taken additional measures, including quarantine and contact tracing of all contacts of the family, but the identification of new cases of infection among other people is considered unlikely [17].

There is currently no specific antiviral therapy for Human metapneumovirus. Treatment is supportive. WHO recommends using the same guidelines as for the monkey virus [18-30].

The 2024 WHO Strategic Advisory Group on Immunization issued conclusions and recommendations [31-33].

As noted by Heikkinen T. et al. [34], Human metapneumovirus is an important cause of lower respiratory tract infections in hospitalized children. The study was conducted in Finland during 2000-2001 among 1338 children aged <13 years during 1 respiratory season.

The results of the survey are shown in Fig. 6. Human metapneumovirus is abbreviated as hMPV.

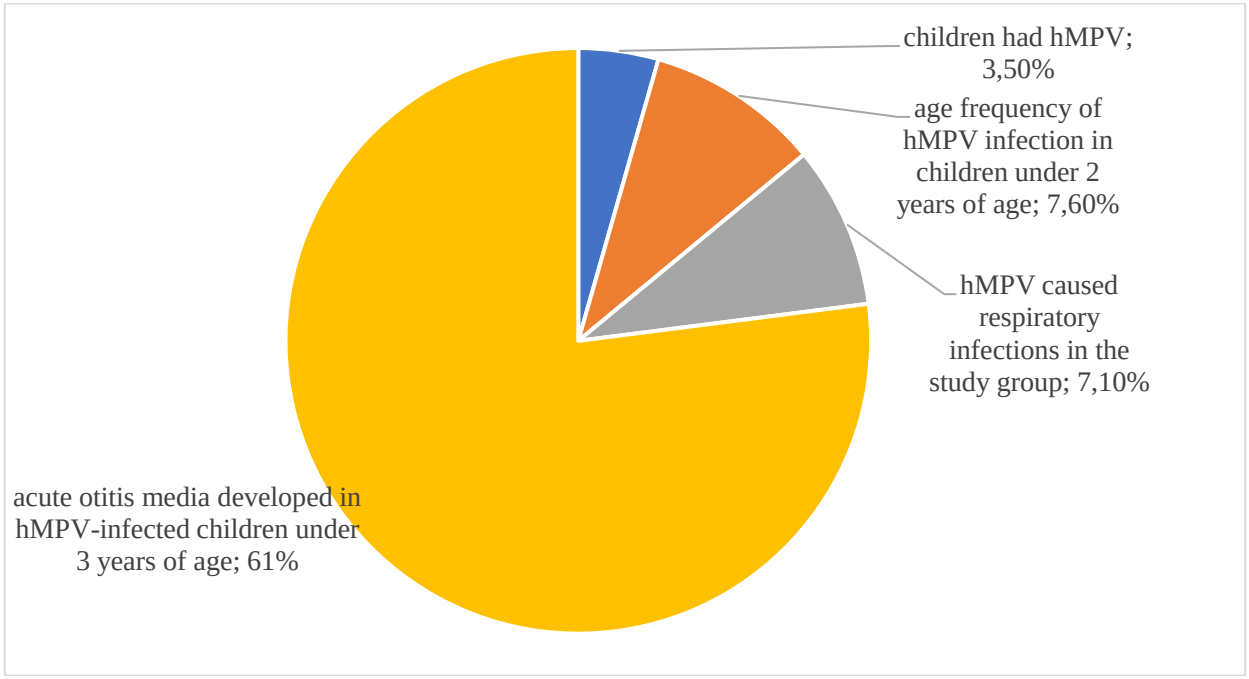

Fig. 6. Results of children's examination for Human metapneumovirus [34].

In Ukraine, free vaccinations against 10 infectious diseases (tuberculosis, hepatitis B, measles, mumps, rubella, diphtheria, tetanus, whooping cough, poliomyelitis, chronic bronchial infection (CHI)) are part of the national preventive vaccination calendar. Vaccines are provided free of charge for children. Free revaccination for adults against diphtheria and tetanus is also provided. In case of violation of the vaccination schedule, for example, if a child missed a vaccination, it is not necessary to start the vaccination course from the beginning. It is important to quickly catch up on missed vaccinations, regardless of how much time has passed since the missed vaccination. To do this, parents can contact a doctor who will help to draw up an individual vaccination plan.

Vaccination coverage is an important criterion for assessing public health security (Fig. 7).

As of December 1, 2024, the vaccination rate among children in Ukraine is:

- against hepatitis B – 83.2%,
- against tuberculosis – 82.5%,
- against chronic bronchial infection Hib infection for children under 1 year old – 90.8%, for one-year-old children – 88.9%,
- against measles, mumps, rubella for one-year-old children – 86%, for 6-year-old children – 77.1%,
- against diphtheria and tetanus for children under 1 year old – 83.3%, for 18-month-old children – 81%, for 6-year-old children – 71.9%, for 16-year-old children – 74%,
- against whooping cough for children under 1 year old – 83.3%, for 18-month-old children – 81%,
- against polio for children under 1 year old – 82.5%, for children 18 months old – 81.2%, for 6-year-olds – 76.9%, for 14-year-olds – 72.9%.

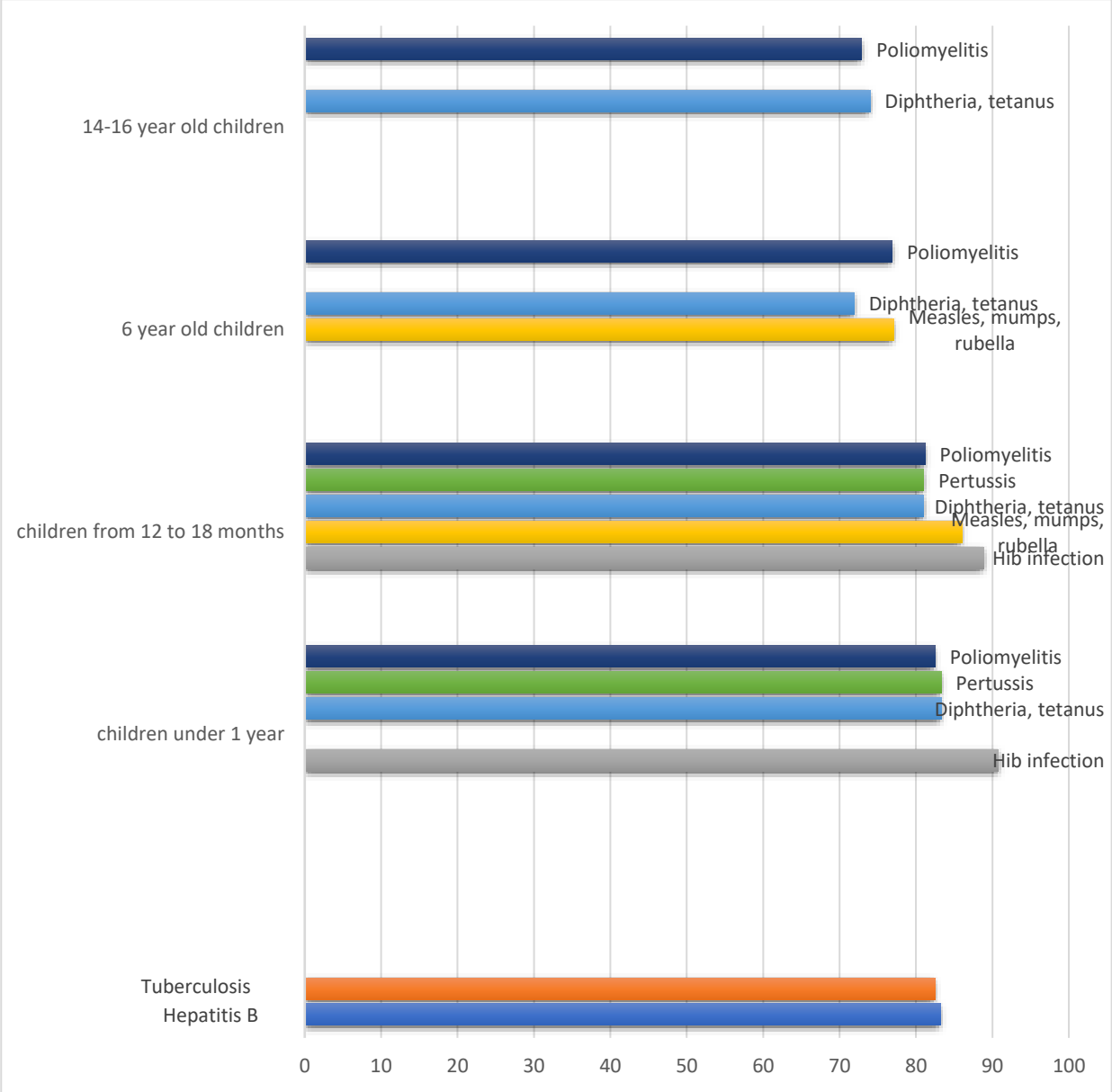

Fig. 7. Vaccination coverage in Ukraine in 2024

Parents can register their children for vaccination with a family doctor or any medical institution that provides vaccination services. During the examination, the doctor can check the child's vaccination status and help catch up on missed vaccinations. Vaccinations can be carried out simultaneously for several diseases or using multicomponent vaccines, which does not overload the immune system, since the viruses in such vaccines are significantly weakened.

In August 2024, the Ministry of Health, together with the Center for Public Health and regional centers for disease control and prevention, with the support of WHO and UNICEF, launched additional immunization activities against pertussis, diphtheria, and tetanus. Revaccination of adults is carried out every 10 years after the last vaccination at 16 years, starting at 26 years and then every 10 years. Vaccination is free of charge and can be done at hospital vaccination points, after making an appointment with a family doctor. Remote communities and cities are also provided with mobile vaccination teams for revaccination among the adult population [35, 36].

The Ministry of Health of Ukraine plans to amend the National Immunization Schedule from 2026, including vaccination of girls aged 12-13 against human papillomavirus infection, as well as to provide for several other changes [37].

The main provisions of the planned changes are given in Table 2.

The purpose of the changes: to increase vaccination coverage, reduce the risks of infectious diseases and mortality, from cervical cancer, and improve the general health of the population. The changes will come into force on January 1, 2026. Their implementation requires centralized procurement of vaccines for free vaccinations [37, 38].

Table 2. Changes to the national vaccination calendar of Ukraine.

Criterion	Changes
Vaccination against human papillomavirus infection	○ Start of administration from 1 January 2026 for girls aged 12 to 13 years. ○ Vaccination will be carried out once. ○ Girls who turn 14 years old after this date will be vaccinated according to different rules. ○ Girls living with HIV and children who have experienced sexual violence should be vaccinated from 9 years of age with a three-dose schedule
Switch to inactivated polio vaccine	○ Replace oral polio vaccine due to its limited efficacy against type 2 poliovirus. ○ This will avoid vaccine-associated paralytic poliomyelitis and reduce the risk of spread of type 2 poliovirus.
Changes in vaccination schedule:	○ The fourth dose of hepatitis B vaccine will be administered at 18 months. ○ Tuberculosis vaccination will be carried out in the first 24 hours after birth (instead of 3-5 days). ○ Cancellation of the sixth dose of polio vaccine at 14 years. ○ Measles, mumps, and rubella vaccination will be carried out at 12 months and 4 years (instead of 12 months and 6 years).
Vaccination against hepatitis B	One of the main changes is the introduction of a fourth dose of hepatitis B vaccine, which children will receive at 18 months. Vaccination against this virus will be carried out at 2 months, 4 months, and 6 months, as well as in the first day of life for newborns at risk. If the mother has a positive test result for hepatitis B (HBsAg "+"), newborns will receive additional preventive measures, including the simultaneous administration of specific hepatitis B immunoglobulin. This will reduce the risks of infection among newborns, for children born to mothers with HIV or those at increased risk due to socio-economic factors. Vaccination against tuberculosis, which was previously carried out on the 3-5th day of life, will now be carried out in the first 24 hours after birth. This will significantly increase the effectiveness of newborn immunization and prevent the development of tuberculosis in the early stages of life. The changes also provide that all children who were not vaccinated in the maternity hospital should be vaccinated by the age of 18, unless contraindications have been previously established.
Vaccination against tuberculosis	The polio vaccination schedule has been changed, in particular, vaccination at 14 years has been canceled. From now on, vaccination will be carried out at the age of 2, 4, 6 months, 18 months and 6 years. At the same time, only

	inactivated polio vaccine (IPV) will be used for all doses of the vaccine. This will reduce the risks of vaccine-associated paralytic poliomyelitis associated with the use of oral polio vaccine (OPV) and provide better protection of the population from poliovirus type 2.
Vaccination against polio	It is proposed to change the vaccination schedule against pertussis, diphtheria and tetanus. Vaccination will be carried out according to the standard scheme: 2, 4, 6 months and 18 months. The changes also concern the use of combined vaccines for children under 7 years of age, which will optimize the immunization process.
Vaccination against pertussis, diphtheria and tetanus	The draft order also provides for a change in the age for vaccination against measles, mumps and rubella. Vaccination will be carried out twice: at 12 months and at 4 years, instead of the current scheme, when the first vaccination is carried out at 12 months and the second at 6 years.
Vaccination against measles, mumps and rubella	The most significant change is the inclusion of vaccination against human papillomavirus in the National Vaccination Calendar. According to the draft, vaccination will be carried out once for girls aged 12 to 13, starting from January 1, 2026. For girls who have HIV or have suffered sexual violence, vaccination will begin at the age of 9. This significantly reduces the risk of developing cervical cancer and other oncological diseases associated with the human papillomavirus, and will significantly reduce the incidence and mortality from these diseases in the future.
Vaccination against human papillomavirus	According to the project, it is planned to combine several vaccines into one appointment, which will reduce the number of visits to medical institutions. This will also reduce the burden on medical institutions and ensure a high level of vaccination coverage. Simultaneous administration of vaccines will be possible if this does not contradict the instructions for a specific vaccine.
Simultaneous administration of vaccines	One of the main changes is the introduction of a fourth dose of hepatitis B vaccine, which children will receive at 18 months. Vaccination against this virus will be carried out at 2 months, 4 months and 6 months, as well as in the first day of life for newborns at risk. If the mother has a positive test result for hepatitis B (HBsAg "+"), newborns will receive additional preventive measures, including the simultaneous administration of specific hepatitis B immunoglobulin. This will reduce the risks of infection among newborns, in particular for children born to mothers with HIV or those at increased risk due to socio-economic factors. Vaccination against tuberculosis, which was previously carried out on the 3-5th day of life, will now be carried out in the first 24 hours after birth. This will significantly increase the effectiveness of newborn immunization and prevent the development of tuberculosis in the early stages of life. The changes also provide that all children who were not vaccinated in the maternity hospital should be vaccinated by the age of 18, unless contraindications have been previously established.

Impact of changes on vaccination effectiveness

All the above is intended not only to improve the protection of the population against major infectious diseases, but also to ensure cost-effectiveness by reducing the cost of treating diseases that could be avoided through timely immunization. Vaccination against human papillomavirus will help significantly reduce the cost of treating cervical cancer and other diseases caused by human papillomavirus, reducing the number of cases and deaths [39-41].

At the same time, reducing the number of cases of polio, whooping cough, measles, and tuberculosis will also have a major impact on the overall health situation in the country. The proposed changes in the vaccination schedule will contribute to better coverage of the population with preventive vaccinations, which will ensure a higher level of collective immunity and reduce the risks of epidemic outbreaks. The introduction of new vaccinations, in particular vaccination against human papillomavirus, as well as the optimization of existing immunization schemes, will contribute to a significant improvement in the health situation and significantly reduce the risks of infectious diseases. The changes proposed in the draft order ensure compliance with modern scientific data and international standards. It will allow Ukraine to increase the level of vaccination coverage and ensure long-term protection of its citizens from vaccine-preventable infections.

Conclusions. Analysis of current challenges associated with Human metapneumovirus, risks in the healthcare and pharmaceutical sectors allowed us to draw the following conclusions. Human metapneumovirus, as a significant respiratory pathogen, is an important cause of respiratory infections. Especially among young children, the elderly, and people with weakened immune systems. Human metapneumovirus can range from mild symptoms to severe complications (bronchitis, pneumonia), which creates a significant burden on the healthcare system. The need to improve preventive measures. Despite the lack of a specific vaccine against Human metapneumovirus, adherence to basic preventive measures remains an effective way to prevent the spread of the virus. At the same time, a promising direction is the development of a vaccine that will reduce morbidity and mortality associated with Human metapneumovirus. Problems of integration into national vaccination programs. The inclusion of the vaccine against Human metapneumovirus in the national vaccination calendar in Ukraine is an important task. It requires scientific justification, appropriate funding, and public support. The successful implementation of such changes requires a broad information campaign and training of medical workers. Seasonality and simultaneous circulation of respiratory viruses. Human metapneumovirus has a pronounced seasonality. The simultaneous circulation of these pathogens creates an additional burden on the healthcare system, which emphasizes the importance of timely diagnosis and prevention. The role of pharmaceuticals. Pharmaceuticals play a key role in the development of effective therapeutic agents and vaccines against Human metapneumovirus. The increase in research and development in this area is an important step towards reducing the global burden of this infection. Impact of Human metapneumovirus on society. Human metapneumovirus causes significant socio-economic costs associated with hospitalizations, treatment, and loss of working days due to the disease. This requires an integrated approach to combating the infection, which includes not only medical, but also social and educational measures. The need for an interdisciplinary approach. The challenges associated with Human metapneumovirus can only be tackled with close cooperation between epidemiologists, physicians, pharmacists, sociologists, and representatives of government agencies. Such an approach will allow optimizing strategies for the prevention and treatment of the infection. Human metapneumovirus is a significant challenge for the modern healthcare system and pharmaceuticals. Its effective prevention and treatment require the efforts of scientists, doctors, pharmacists, and government institutions aimed at increasing vaccination rates, developing new therapeutics, and raising public awareness about the prevention of respiratory infections.

Declaration of conflict interest. The author declares no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The author confirms that they are the authors of this work and have approved it for publication. The author also certify that the obtained data and research were conducted in compliance with the requirements of moral and ethical

principles based on medical and pharmaceutical law, and in the absence of any commercial or financial relationships that could be interpreted as potential conflict of interest.

Funding. The author states, that this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability statement. The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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