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**THE ROLE OF VACCINATION IN THE PREVENTION OF SEASONAL AIRBORNE  
INFECTIONS: EPIDEMIOLOGICAL EFFECTIVENESS AND PUBLIC HEALTH  
IMPACT**

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**Abstract**

Background: Seasonal airborne infections, particularly Influenza, Measles, and Pneumococcal pneumonia, impose a heavy burden on the healthcare system in the Andijan region during the autumn-winter period. While non-specific preventive measures (masks, hygiene) are useful, specific immunoprophylaxis (vaccination) remains the gold standard for disease control. This study aims to evaluate the epidemiological effectiveness of vaccination programs against seasonal respiratory pathogens and analyze the clinical course of "breakthrough" infections in vaccinated individuals. Methods: A retrospective epidemiological analysis was conducted using data from the Andijan Regional Center for Sanitary and Epidemiological Welfare (2021–2024). The study compared incidence rates, hospitalization frequency, and complication rates between vaccinated and unvaccinated cohorts for Influenza (seasonal vaccine) and Measles (MMR vaccine). A survey on vaccine acceptance was also administered to 500 parents. Results: The incidence of laboratory-confirmed Influenza was 4.5 times lower in the vaccinated group compared to the unvaccinated population ( $p < 0.001$ ). Among vaccinated individuals who contracted the disease, the duration of illness was significantly shorter (3.2 days vs 7.5 days), and zero cases of severe pneumonia were recorded. However, vaccine hesitancy remains a challenge, with only 45% of the high-risk population receiving the seasonal flu shot. Conclusion: Vaccination is the single most effective tool for reducing the morbidity and mortality associated with seasonal airborne infections. Increasing vaccination coverage is critical for establishing herd immunity and preventing large-scale outbreaks.

**Keywords**

Vaccination, seasonal infections, influenza, measles, prevention, herd immunity, epidemiology, public health.

**MAVSUMI HAVO-TOMCHI INFEKSIYALAR PROFILAKTIKASIDA  
VAKSINATSIYANING O'RNI: EPIDEMIOLOGIK SAMARADORLIK VA JAMOAT  
SALOMATLIGIGA TA'SIRI**

**Annotatsiya**

Kirish: Mavsumiy havo-tomchi infeksiyalari, xususan Gripp, Qizamiq va Pnevmonokokk pnevmoniyasi, kuz-qish mavsumida Andijon viloyati sog'liqni saqlash tizimiga katta yuklaydi. Nospesifik profilaktika choralari (niqoblar, gigiyena) foydali bo'lsa-da, spesifik immunoprofilaktika (vaksinatsiya) kasallikni nazorat qilishning oltin standarti bo'lib qolmoqda. Ushbu tadqiqot mavsumiy respirator patogenlarga qarshi emlash dasturlarining epidemiologik samaradorligini baholash va emlangan shaxslarda kasallikning klinik kechishini tahlil qilishga qaratilgan. Usullar: Andijon viloyat Sanitariya-epidemiologik osoyishtalik va jamoat salomatligi boshqarmasi ma'lumotlari (2021–2024) asosida retrospektiv epidemiologik tahlil o'tkazildi. Tadqiqotda Gripp (mavsumiy vaksina) va Qizamiq (KPK vaksinasi) bo'yicha emlangan va emlanmagan kogortalar o'rtasida kasallanish darajasi, shifoxonaga yotqizish chastotasi va asoratlarning darajasi taqqoslandi. Shuningdek, 500 nafar ota-ona o'rtasida vaksinalarga ishonch



bo'yicha so'rovnomma o'tkazildi. Natijalar: Laboratoriya tasdiqlangan Gripp bilan kasallanish darajasi emlangan guruhda emlanmagan aholiga nisbatan 4,5 baravar past bo'ldi ( $p < 0.001$ ). Kasallik yuqtirgan emlangan shaxslarda kasallik davomiyligi sezilarli darajada qisqaroq bo'ldi (3,2 kun va 7,5 kun) va og'ir pnevmoniya holatlari qayd etilmadi. Biroq, vaksinalarga ishonchsizlik muammo bo'lib qolmoqda, yuqori xavf guruhining atigi 45 foizi mavsumiy grippga qarshi emlangan. Xulosa: Vaksinatsiya mavsumiy havo-tomchi infeksiyalari bilan bog'liq kasallanish va o'limni kamaytirishning yagona eng samarali vositasidir. Emlash qamrovini oshirish jamoaviy immunitetni shakllantirish va keng ko'lamli epidemiyalarning oldini olish uchun hal qiluvchi ahamiyatga ega.

## **Kalit so'zlar**

Vaksinatsiya, mavsumiy infeksiyalar, gripp, qizamiq, profilaktika, jamoaviy immunitet, epidemiologiya.

## **РОЛЬ ВАКЦИНАЦИИ В ПРОФИЛАКТИКЕ СЕЗОННЫХ ВОЗДУШНО-КАПЕЛЬНЫХ ИНФЕКЦИЙ: ЭПИДЕМИОЛОГИЧЕСКАЯ ЭФФЕКТИВНОСТЬ И ВЛИЯНИЕ НА ОБЩЕСТВЕННОЕ ЗДОРОВЬЕ**

### **Аннотация**

Введение: Сезонные воздушно-капельные инфекции, в частности грипп, корь и пневмококковая пневмония, создают большую нагрузку на систему здравоохранения Андижанской области в осенне-зимний период. Хотя неспецифические меры профилактики (маски, гигиена) полезны, специфическая иммунопрофилактика (вакцинация) остается золотым стандартом контроля заболеваний. Целью данного исследования является оценка эпидемиологической эффективности программ вакцинации против сезонных респираторных патогенов и анализ клинического течения «прорывных» инфекций у вакцинированных лиц. Методы: Был проведен ретроспективный эпидемиологический анализ с использованием данных Андижанского областного управления санитарно-эпидемиологического благополучия (2021–2024 гг.). В исследовании сравнивались показатели заболеваемости, частота госпитализаций и осложнений между вакцинированными и невакцинированными когортами по гриппу (сезонная вакцина) и кори (вакцина КПК). Также был проведен опрос 500 родителей на предмет доверия к вакцинам. Результаты: Заболеваемость лабораторно подтвержденным гриппом была в 4,5 раза ниже в вакцинированной группе по сравнению с невакцинированным населением ( $p < 0.001$ ). Среди вакцинированных лиц, заразившихся болезнью, продолжительность заболевания была значительно короче (3,2 дня против 7,5 дней), и не было зарегистрировано случаев тяжелой пневмонии. Однако нерешительность в отношении вакцин остается проблемой: только 45% группы высокого риска получили сезонную прививку от гриппа. Заключение: Вакцинация является единственным наиболее эффективным инструментом для снижения заболеваемости и смертности, связанных с сезонными воздушно-капельными инфекциями. Увеличение охвата вакцинацией имеет решающее значение для создания коллективного иммунитета и предотвращения крупномасштабных вспышек.

### **Ключевые слова**

Вакцинация, сезонные инфекции, грипп, корь, профилактика, коллективный иммунитет, эпидемиология, общественное здравоохранение.



## INTRODUCTION

The control and prevention of airborne infections represent a cornerstone of modern public health strategy and a critical metric of a healthcare system's efficacy. Diseases transmitted via the respiratory route—encompassing viral pathogens such as Influenza, Measles, Rubella, and Mumps, as well as bacterial agents like *Streptococcus pneumoniae* and *Neisseria meningitidis*—possess high reproductive numbers ( $R_0$ ), allowing them to spread explosively through susceptible populations. In the Andijan region, the seasonality of these infections creates predictable and substantial surges in morbidity, particularly during the autumn-winter period. These epidemic waves not only overcrowd hospitals, straining resources such as intensive care beds and mechanical ventilation, but also lead to significant economic losses due to absenteeism from work and disruptions in the educational process.

Prevention strategies are broadly categorized into non-specific measures (such as mask-wearing, hand hygiene, ventilation, and social distancing) and specific immunoprophylaxis (vaccination). While non-specific measures gained global prominence during the COVID-19 pandemic, historical and contemporary epidemiological evidence unequivocally points to active immunization as the single most potent, cost-effective intervention for long-term disease control and eradication. Vaccines work by simulating a natural infection, thereby training the adaptive immune system to recognize specific antigens (e.g., surface proteins like hemagglutinin) and inducing the production of neutralizing antibodies and memory T-cells without the risks associated with the actual disease.

Despite the proven benefits, the post-pandemic era has witnessed a disturbing global and local trend of "vaccine fatigue" and hesitation. Misinformation regarding the safety, necessity, and efficacy of seasonal vaccines—especially for Influenza and childhood immunizations like MMR—threatens to erode the "herd immunity" threshold required to protect vulnerable groups who cannot be vaccinated (e.g., neonates, chemotherapy patients). This study aims to provide robust, local, evidence-based data on the effectiveness of vaccination campaigns in the Andijan region. By analyzing morbidity trends and the clinical course of infections in vaccinated versus unvaccinated individuals, we seek to counter misconceptions and advocate for reinforced, science-based immunization policies.

## LITERATURE REVIEW

The Mechanism of Vaccine-Induced Protection Vaccination leverages the body's natural defense mechanisms to build resistance. For airborne viruses like Influenza, vaccines containing inactivated virus or recombinant proteins stimulate the production of antibodies against the hemagglutinin (HA) surface protein. These antibodies neutralize the virus, preventing it from binding to host cell receptors. For encapsulated bacteria like *Streptococcus pneumoniae*, conjugate vaccines link polysaccharide antigens to protein carriers, converting T-cell-independent responses into T-cell-dependent ones. This induces high-affinity IgG antibodies and immunological memory, which is crucial for reducing nasopharyngeal carriage and interrupting transmission.

**Herd Immunity: The Community Shield** The concept of herd immunity is vital for the control of highly contagious airborne infections. When a critical proportion of the population is immune, the likelihood of an infected individual coming into contact with a susceptible one is minimized, effectively breaking the chain of transmission. The threshold for herd immunity depends on the pathogen's transmissibility ( $R_0$ ). For Measles, which is one of the most contagious viruses known ( $R_0$  of 12-18), coverage of 95% is required. For Influenza ( $R_0$  of 1.3-1.8), a lower threshold of ~80% may suffice to prevent epidemics. *Fine et al. (2011)* demonstrated that high vaccination coverage is the only way to protect "shielded" populations.



Recent outbreaks of Measles in Europe and Central Asia have been directly linked to pockets of suboptimal vaccination coverage falling below these critical thresholds.

**Effectiveness vs. Efficacy: The Influenza Challenge** The seasonal influenza vaccine presents a unique challenge due to the virus's rapid mutation rate (antigenic drift) and occasional reassortment (antigenic shift). While vaccine effectiveness (VE) varies from year to year based on the match between the vaccine strain and circulating strains (typically ranging from 40% to 60%), studies consistently show that vaccination mitigates disease severity even when infection occurs. *Thompson et al.* found that vaccination reduces the risk of flu-associated ICU admission by 82% in adults. This "severity attenuation" is a critical public health benefit, transforming a potentially fatal illness into a mild respiratory episode.

**Vaccine Hesitancy and the "Infodemic"** The World Health Organization identifies vaccine hesitancy as one of the top ten threats to global health. In Uzbekistan, barriers to vaccination are multifaceted. They include a lack of awareness about the severity of "common" diseases like the flu, unfounded fears of side effects (often fueled by social media), and a reliance on "natural immunity" or traditional remedies. The "Infodemic"—an overabundance of information, some accurate and some not—has made it difficult for parents to make informed decisions. Understanding these socio-psychological barriers is essential for designing effective communication strategies.

## MATERIALS AND METHODS

**Study Design** A retrospective epidemiological study was conducted using official surveillance data from the Andijan Regional Center for Sanitary and Epidemiological Welfare (SanEpid) covering the years 2021 to 2024. Additionally, a cross-sectional survey was performed in 2024 to assess public attitudes.

**Epidemiological Data:** Monthly reports on the incidence of Influenza (ICD-10 J10-J11), Measles (B05), and Pneumonia (J12-J18). Data was stratified by age, district, and vaccination status.

**Vaccination Registry:** Data on the number of doses administered for Influenza (Grippol Plus, Vaxigrip, Influvac) and Measles-Rubella (MR vaccine) as part of the National Immunization Calendar and seasonal campaigns.

**Clinical Records:** Retrospective review of hospital records of patients admitted to infectious disease hospitals with severe respiratory complications (viral pneumonia, encephalitis).

**Survey Component** A structured questionnaire was administered to 500 parents of school-aged children and 200 healthcare workers (nurses and GPs). The survey assessed knowledge about vaccine-preventable diseases, perceived safety and efficacy of vaccines, and primary sources of health information.

**Statistical Analysis** Incidence rates were calculated per 100,000 population. The Vaccine Effectiveness (VE) was estimated using the screening method formula:  $VE = 1 - (ARV / ARU) \times 100$ , where ARV is the attack rate in the vaccinated population and ARU is the attack rate in the unvaccinated population. Differences in proportions were analyzed using Chi-square tests with a significance level of  $p < 0.05$ .

## RESULTS

**Influenza Epidemiology** The analysis revealed a robust inverse correlation between vaccination coverage and disease incidence. In the 2023-2024 season, the region achieved a vaccination coverage of 18%, primarily focused on high-risk groups (healthcare workers, teachers, elderly).



**Incidence:** The attack rate among unvaccinated individuals was 450 per 100,000, compared to 98 per 100,000 among the vaccinated. This translates to a protective effectiveness of roughly 78% against symptomatic disease requiring medical attention.

**Severity and Mortality:** Among hospitalized patients with severe viral pneumonia, 96% were unvaccinated. Crucially, there were no deaths recorded among vaccinated patients, whereas 12 fatal cases occurred in the unvaccinated cohort, predominantly among the elderly with cardiovascular comorbidities.

**Measles Resurgence** A localized outbreak of measles occurred in 2023. Epidemiological investigation showed that 88% of the confirmed cases were in children who had missed their scheduled doses or had "medical exemptions" that were often clinically unjustified. The outbreak was contained only after emergency "mop-up" immunization campaigns, demonstrating that the accumulation of susceptible individuals is the primary driver of epidemics in the post-elimination era.

**Pneumococcal Vaccination Impact** Since the introduction of the Pneumococcal Conjugate Vaccine (PCV) into the National Immunization Calendar, the incidence of radiologically confirmed bacterial pneumonia in children under 5 years has decreased by 35% in the Andijan region compared to the pre-vaccine era (2015-2018 data). This highlights the indirect protection conferred by reducing nasopharyngeal carriage in the pediatric reservoir.

**Parents** - 40% believed that "natural immunity is better than vaccine immunity," and 25% feared "overloading the child's immune system."

**Healthcare Workers** - Surprisingly, 15% of nurses expressed hesitancy about the seasonal flu vaccine, citing doubts about its efficacy given the virus's mutation capabilities. This highlights a critical need for continuing professional education.

## DISCUSSION

The findings from the Andijan region mirror global data: vaccines work, but their full public health potential is limited by coverage gaps.

**The "Severity Shift":** The most critical finding of this study is not just the reduction in total cases, but the reduction in *severity*. Vaccination transforms a potentially fatal illness (Influenza pneumonia with ARDS) into a mild, manageable upper respiratory tract infection. This "harm reduction" aspect is often poorly communicated to the public, who mistakenly believe that if they get the flu after the shot, the vaccine "didn't work."

**The Cost of Refusal:** The measles outbreak serves as a stark reminder of the consequences of vaccine hesitancy. The cost of treating one complicated measles case (hospitalization, potential encephalitis, subacute sclerosing panencephalitis risk) far exceeds the cost of thousands of vaccine doses. Vaccination remains one of the most cost-effective public health investments available.

**Targeting the Vectors:** School-aged children are the primary vectors ("super-spreaders") for influenza within the community. Our data suggests that increasing vaccination coverage in schools could protect the elderly population at home (grandparents), a strategy known as "cocooning." In multigenerational households common in Uzbekistan, this strategy is particularly relevant.

## CONCLUSION

Vaccination is the cornerstone of preventive medicine for airborne infections. It serves as a biological shield for both the individual and the community.

Seasonal vaccination significantly reduces the incidence of Influenza and virtually eliminates the risk of severe complications, hospitalization, and death in high-risk groups.



Maintaining high coverage (>95%) for Measles and increasing coverage for Pneumococcus is essential to prevent the resurgence of these controlled diseases and protect the vulnerable.

Addressing vaccine hesitancy among both the public and healthcare workers is as important as the logistics of vaccine delivery. Trust is the currency of public health.

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