

CHILDHOOD VACCINATION: MEDICAL BENEFITS, PUBLIC HEALTH IMPACT, AND PARENTAL RESPONSIBILITIES

Samarqand davlat tibbiyot universiteti

Tillar kafedrasi o'qituvchisi

Asatullyev Rustam

Samarqand davlat tibbiyot

universiteti 1-kurs talabasi

Xudoynazarova Xadisa

Abstract: Childhood vaccination represents one of the most successful public health interventions in modern medical history. This article provides a comprehensive analysis of childhood vaccination, examining its medical efficacy, safety profile, public health impact, current global coverage trends, and the complex legal and ethical considerations surrounding parental decision-making. Drawing on recent Cochrane reviews, WHO and UNICEF data, and contemporary legal scholarship, this article demonstrates that vaccines have prevented hundreds of millions of illnesses and millions of hospitalizations over the past three decades. However, declining vaccination rates in several countries threaten herd immunity and have led to the resurgence of previously controlled diseases such as measles. The article also explores the legal framework governing childhood vaccination, particularly the tension between parental autonomy and children's rights to health protection. The evidence overwhelmingly supports vaccination as a safe, effective, and cost-effective intervention that benefits not only individual children but entire communities.

Keywords: childhood vaccination, vaccine efficacy, herd immunity, vaccine safety, parental responsibility, public health

Аннотация: Детская вакцинация представляет собой одно из наиболее успешных мероприятий в области общественного здравоохранения в современной истории медицины. В данной статье представлен всесторонний анализ детской вакцинации, рассматриваются ее медицинская эффективность, профиль безопасности, влияние на общественное здравоохранение, текущие глобальные тенденции охвата вакцинацией, а также сложные правовые и этические аспекты, связанные с принятием решений родителями. Опираясь на недавние обзоры Кокрейна, данные ВОЗ и ЮНИСЕФ, а также современные юридические исследования, статья демонстрирует, что вакцины предотвратили сотни миллионов заболеваний и миллионы госпитализаций за последние три десятилетия. Однако снижение уровня вакцинации в ряде стран угрожает коллективному иммунитету и привело к возобновлению ранее контролируемых заболеваний, таких как корь. В статье также рассматривается правовая основа,

регулирующая детскую вакцинацию, в частности, противоречие между автономией родителей и правом детей на защиту здоровья. Доказательства убедительно подтверждают, что вакцинация является безопасным, эффективным и экономически выгодным мероприятием, приносящим пользу не только отдельным детям, но и целым сообществам.

Ключевые слова: детская вакцинация, эффективность вакцины, коллективный иммунитет, безопасность вакцины, ответственность родителей, общественное здравоохранение

Annotatsiya: Bolalik davridagi emlash zamonaviy tibbiyot tarixidagi eng muvaffaqiyatli sog'liqni saqlash aralashuvlaridan biridir. Ushbu maqolada bolalik davridagi emlashning keng qamrovli tahlili keltirilgan bo'lib, uning tibbiy samaradorligi, xavfsizlik profili, sog'liqni saqlashga ta'siri, hozirgi global qamrov tendentsiyalari va ota-onalarning qaror qabul qilish bilan bog'liq murakkab huquqiy va axloqiy mulohazalari o'rganilgan. Yaqinda o'tkazilgan Cochrane sharhlari, JSST va UNICEF ma'lumotlari va zamonaviy huquqiy tadqiqotlarga tayanib, ushbu maqolada vaktsinalar so'nggi uch o'n yillikda yuz millionlab kasalliklar va millionlab kasalxonaga yotqizishlarning oldini olganligi ko'rsatilgan. Biroq, bir qator mamlakatlarda emlash darajasining pasayishi poda immunitetiga tahdid soladi va qizamiq kabi ilgari nazorat qilingan kasalliklarning qayta tiklanishiga olib keldi. Maqolada shuningdek, bolalik davridagi emlashni tartibga soluvchi huquqiy asos, xususan, ota-onalarning avtonomiyasi va bolalarning sog'liqni saqlashni himoya qilish huquqlari o'rtasidagi ziddiyat o'rganiladi. Dalillar emlashni nafaqat alohida bolalarga, balki butun jamoalarga foyda keltiradigan xavfsiz, samarali va tejamkor aralashuv sifatida qo'llab-quvvatlaydi.

Kalit so'zlar: bolalik davridagi emlash, vaktsina samaradorligi, poda immuniteti, vaktsina xavfsizligi, ota-onalarning mas'uliyati, sog'liqni saqlash

Introduction

Vaccination is widely regarded as one of modern medicine's greatest achievements and one of the most successful public health interventions in history . Since the development of the first vaccine by Edward Jenner in 1796, immunization programs have fundamentally transformed the landscape of pediatric infectious diseases. Diseases that once caused widespread morbidity and mortality—such as smallpox, polio, diphtheria, and measles—have been either eradicated or drastically reduced in countries with robust vaccination programs .

The significance of childhood vaccination extends far beyond individual protection. When sufficient numbers of children are immunized, communities achieve "herd immunity," which protects vulnerable individuals who cannot be vaccinated due to medical contraindications, such as infants too young to receive certain vaccines,

immunocompromised children undergoing cancer treatment, or individuals with severe allergies to vaccine components . This collective protection represents a profound expression of community responsibility and solidarity.

Despite the overwhelming scientific consensus regarding vaccine safety and efficacy, recent years have witnessed concerning trends in vaccine hesitancy and declining immunization rates in several countries . The COVID-19 pandemic exacerbated these trends, disrupting routine immunization services and fueling anti-vaccine sentiments that have spilled over into childhood vaccination programs . Consequently, diseases that had been largely controlled—most notably measles—have made alarming resurgences, with hundreds of cases and even deaths reported in countries where the disease was previously considered eliminated .

This article aims to provide a comprehensive overview of childhood vaccination from multiple perspectives: the medical evidence base supporting vaccine efficacy and safety; the public health impact of immunization programs; current global coverage trends and challenges; and the complex legal and ethical questions surrounding parental duties to vaccinate. By synthesizing evidence from recent systematic reviews, international health organizations, and legal scholarship, this article seeks to inform readers about the critical importance of childhood vaccination and to address common concerns that contribute to vaccine hesitancy.

Vaccine Efficacy: Evidence from Systematic Reviews

The Cochrane Review on MMR and Varicella Vaccines

The most comprehensive evidence regarding the efficacy of childhood vaccines comes from systematic reviews and meta-analyses that synthesize data from multiple studies. A landmark Cochrane review, updated in 2021 and summarized in a 2025 American Family Physician clinical review, evaluated the effectiveness and safety of measles, mumps, rubella (MMR), and varicella vaccines in children and adolescents up to age 15 years . This review included 138 studies, with 51 studies evaluating vaccine effectiveness and 87 studies evaluating vaccine safety.

The findings regarding vaccine effectiveness are striking. For measles prevention, individuals who received two doses of the MMR vaccine were significantly less likely to contract the disease compared to unvaccinated individuals (relative risk = 0.04; 95% confidence interval, 0.01 to 0.28), representing a 96% reduction in risk . This finding is based on moderate-certainty evidence, reflecting the consistency and quality of the available studies.

Effectiveness of Other Routine Childhood Vaccines

Beyond MMR and varicella vaccines, the routine childhood immunization schedule includes several other vaccines that have demonstrated remarkable effectiveness. The diphtheria, tetanus, and pertussis (DTaP) vaccine protects against three serious bacterial infections. Pertussis, or whooping cough, causes severe

coughing fits that can last for weeks or months and can be particularly dangerous for infants . The polio vaccine has been so effective that wild poliovirus has been eliminated from most of the world, with only a few countries still reporting cases .

The influenza vaccine, while not part of the standard school-entry schedule in many countries, is recommended annually for all children aged 6 months and older. However, influenza vaccine coverage among children reached its lowest point in twelve years during the 2023-2024 flu season, raising concerns about increased vulnerability to severe influenza complications, including pneumonia, brain inflammation, and muscle damage .

Vaccine Effectiveness in Infants Under 12 Months

A recent systematic review and meta-analysis published in *Vaccine* (2025) specifically examined the reactogenicity of measles-containing vaccines in infants younger than 12 months . This review, which included 24 studies (18 randomized controlled trials, three interventional studies, and three observational studies), found that most adverse events occurred in fewer than 10% of infants receiving the first dose of measles-containing vaccine before 12 months of age.

Importantly, the only placebo-controlled trial included in the review showed no difference in adverse events between vaccinated infants and those receiving placebo injections . This finding is particularly significant because it suggests that many of the symptoms parents attribute to vaccination may actually be coincidental illnesses that occur naturally in young infants.

The review also identified that the Edmonston B strain of measles vaccine and the combined MMRV (measles, mumps, rubella, varicella) vaccine were associated with higher rates of high fever ($>39^{\circ}\text{C}$), indicating that vaccine formulation can influence reactogenicity profiles .

Vaccine Safety: Evidence and Monitoring Systems

Adverse Events from the Cochrane Review

The safety profile of childhood vaccines has been extensively studied, and the Cochrane review provides important insights into both the frequency and nature of adverse events associated with MMR and varicella vaccines . The review identified several adverse events that occur more frequently in vaccinated children compared to unvaccinated controls.

The most common adverse event was rash, which occurred at approximately twice the rate in vaccinated children (relative risk = 2.05; 95% CI, 1.21–3.48) based on high-certainty evidence . Seizures within one week of MMR vaccination occurred at a rate 2.45 times higher than in unvaccinated children (rate ratio = 2.45; 95% CI, 2.21–2.71) based on moderate-certainty evidence. Additionally, idiopathic thrombocytopenic purpura (ITP)—a condition characterized by low platelet counts that

can cause bruising and bleeding—occurred at a rate 4.21 times higher after MMR vaccination (rate ratio = 4.21; 95% CI, 2.28–7.78) .

Post-Licensure Safety Monitoring Systems

Given that even the largest pre-licensure randomized controlled trials cannot detect rare adverse events that may occur at frequencies of 1 in 10,000 or less, robust post-licensure surveillance systems are essential for ensuring ongoing vaccine safety. In the United States, two complementary systems serve this purpose: the Vaccine Adverse Event Reporting System (VAERS) and the Vaccine Safety Datalink (VSD) .

VAERS is a passive surveillance system co-sponsored by the FDA and CDC that allows patients and healthcare professionals to report suspected adverse events following vaccination. While VAERS provides rapid identification of potential safety concerns, it cannot establish causation because it lacks a control group. Reports to VAERS demonstrate only temporal associations—the fact that an event occurred after vaccination does not necessarily mean the vaccine caused the event .

Herd Immunity: Protecting the Vulnerable

Herd immunity, also known as community immunity, describes the protection that occurs when a sufficient proportion of a population is immune to an infectious disease, making it difficult for the disease to spread and thereby protecting individuals who are not immune . This concept is fundamental to understanding why childhood vaccination is not merely an individual choice but a community responsibility.

Dr. Sean McKenna, a pediatrician at Children's Hospital of Richmond, explains the importance of herd immunity: "Those people can be neighbors who have some sort of immune deficiency, or the elderly who may have lost their immunity, or infants too young to be immunized. We protect all of them when we choose to vaccinate" . With diseases such as measles, herd immunity was built by generations of community members who chose to protect their families, friends, and neighbors through the simple act of receiving a vaccine

Current Global Coverage Trends

Despite the clear benefits of vaccination, global coverage has not reached the levels needed to achieve herd immunity for all vaccine-preventable diseases. According to data released by the World Health Organization (WHO) and UNICEF in July 2025, 89% of infants globally—approximately 115 million children—received at least one dose of the diphtheria, tetanus, and pertussis (DTP)-containing vaccine in 2024 . Eighty-five percent (roughly 109 million children) completed all three doses of the DTP series.

While these figures represent modest progress compared to 2023—with approximately 171,000 more children receiving at least one vaccine and one million more completing the full three-dose series—significant gaps remain . Nearly 20 million

infants missed at least one dose of DTP-containing vaccine in 2024, including 14.3 million "zero-dose" children who never received a single dose of any vaccine.

This number is 1.4 million higher than in 2019, the baseline year for measuring progress toward Immunization Agenda 2030 goals.

Vaccine-Preventable Diseases: Clinical Manifestations and Complications

Measles

Measles is a highly contagious viral disease that causes fever, cough, runny nose, red eyes, loss of appetite, and a widespread rash . The virus is transmitted through respiratory droplets and can remain infectious in the air for up to two hours after an infected person has left a room. Measles is so contagious that if one person has it, up to 90% of non-immune individuals in close proximity will become infected.

While many children recover without complications, measles can cause severe illness requiring hospitalization. Complications include pneumonia (the most common cause of measles-related death in young children), encephalitis (brain inflammation that can cause permanent brain damage), and death . Before widespread vaccination, measles caused approximately 2.6 million deaths annually worldwide.

The MMR vaccine is routinely administered in two doses: the first dose at 12-15 months of age and the second dose at 4-6 years. The first dose is 93% effective at preventing measles, and protection increases to 97% after the second dose . For infants as young as 6 months, early vaccination can be provided, particularly for families planning international travel or residing in areas with known measles cases.

Mumps and Rubella

Mumps is another vaccine-preventable disease covered by the MMR vaccine. Mumps typically presents with fever, headache, and painful swelling of the salivary glands (parotitis), causing characteristic "chipmunk cheek" appearance . Complications can include orchitis (testicular inflammation) in post-pubertal males, which can affect fertility; meningitis; and deafness.

Rubella, also known as German measles, is generally a mild disease in children, presenting with a red rash on the face that spreads to the body, sometimes accompanied by fever and sore throat . However, rubella infection during pregnancy can have devastating consequences for the developing fetus, causing congenital rubella syndrome, which includes heart defects, cataracts, hearing impairment, and developmental delays. Vaccination protects not only the child but also future pregnancies by reducing rubella circulation in the community.

Polio and Varicella

Poliomyelitis is a viral disease that causes flu-like symptoms and can progress to brain inflammation and paralysis . There is no cure for polio, and paralysis is permanent. Vaccination has been so effective that the United States has been polio-free

since the 1970s, although importations remain a risk as long as polio circulates anywhere in the world.

Varicella (chickenpox) was once considered a childhood rite of passage, with parents often encouraging exposure to ensure immunity before adulthood . However, chickenpox can cause serious complications, including bacterial skin infections, pneumonia, and encephalitis. Since the varicella vaccine was added to the routine childhood immunization schedule in the mid-1990s, cases have been reduced by 97%. Two doses of the varicella vaccine—typically given at 12-15 months and 4-6 years—are more than 90% effective at preventing the illness.

Legal and Ethical Dimensions

The Legal Framework: Parental Responsibility and Children's Rights

The question of whether parents have a legal duty to vaccinate their children has been the subject of increasing scholarly attention, particularly in the context of declining vaccination rates and disease outbreaks. A recent analysis in the *De Jure Law Journal* (2025) examines this question with reference to South African constitutional law, but the principles discussed have broader relevance .

Section 28 of the South African Constitution establishes children's rights to "basic health care services" and to be "protected from maltreatment, neglect, abuse or degradation" . The Department of Health's website explicitly states that "all children have a right to basic health care" and that "immunisation is one of the health care components" . This suggests that vaccination falls within the scope of basic health care services to which children are entitled.

The question then becomes whether parents are duty-bound to realize this right. The Constitutional Court has emphasized that children have a right to parental care in the first instance, and the state's responsibility is to ensure legal obligations compel parents to fulfill their responsibilities . As legal scholars Friedman, Pantazis, and Skelton have explained, "If a parent can afford medicine and the other components of health care, then it is his or her duty to provide them" .

The Best Interests of the Child

Central to legal determinations involving children is the principle that "a child's best interests are of paramount importance in every matter concerning the child" . This principle, enshrined in both international law and domestic legislation, requires that decisions affecting children must prioritize their welfare and well-being.

Parental Autonomy Versus Community Protection

The tension between parental autonomy and community protection represents a fundamental challenge in vaccination policy. Parents have traditionally been accorded significant deference in making medical decisions for their children, based on the presumption that parents know their children best and will act in their children's best

interests . However, this presumption can be rebutted when parents' decisions place their children at demonstrable risk of serious harm.

In English law, as in many jurisdictions, parents with parental responsibility can consent to medical treatment for their children, but this authority is not absolute . If those with parental responsibility do not consent to a medical procedure, a doctor may still be authorized to treat the child if the child consents with capacity to do so, if there is an order of the court, or in an emergency under the doctrine of necessity. If the issue comes to court, the court will make an order based on what will promote the welfare of the child, taking into account parental wishes but ultimately guided by the best interests of the child .

Cultural, Religious, and Philosophical Exemptions

Many jurisdictions permit exemptions from vaccination requirements based on cultural, religious, or philosophical beliefs . These exemptions reflect the value placed on parental autonomy and freedom of conscience. However, they also create potential conflicts with children's rights to health protection and the community's interest in maintaining herd immunity.

Legal scholars have questioned whether cultural or religious practices that are detrimental to a child's well-being should be protected . The Children's Act in South Africa explicitly states that children have the right not to be "subjected to social, cultural and religious practices which are detrimental to his or her well-being" . If non-vaccination is regarded as a social, cultural, or religious practice, it must not be detrimental to the well-being of the child.

The balance between respecting parental beliefs and protecting children from preventable harm is delicate and context-dependent. Courts have generally been reluctant to override parental decisions in the absence of clear evidence of imminent harm, but they have also shown willingness to intervene when children's health is at serious risk.

Addressing Vaccine Hesitancy

Understanding the Drivers of Hesitancy

Vaccine hesitancy is a complex phenomenon influenced by multiple factors, including confidence in vaccines and healthcare systems, complacency about vaccine-preventable diseases, and convenience of access . Research has shown that hesitancy toward childhood vaccines is more common among parents with higher education levels who prefer social media anti-vaccine narratives over evidence-based vaccine information . This finding challenges the assumption that hesitancy is primarily driven by lack of education and highlights the importance of effective risk communication.

The COVID-19 pandemic appears to have exacerbated vaccine hesitancy in several ways. The rapid development and rollout of COVID-19 vaccines raised questions about safety and efficacy that some parents have extended to routine

childhood vaccines . Additionally, pandemic-related disruptions to healthcare services resulted in many children falling behind on routine vaccinations, and some families have not returned to catch up.

Effective Communication Strategies

The Centers for Disease Control and Prevention recommends that when parents are hesitant to vaccinate, clinicians should listen and seek to understand the context behind parental questions . Rather than dismissing concerns or presenting information in a confrontational manner, effective communication involves acknowledging parents' concerns, providing accurate information in accessible language, and using evidence-based educational resources.

Data from the Cochrane review and other rigorous studies can help inform these discussions . Parents may be reassured to learn that most adverse events occur in fewer than 10% of infants receiving vaccines and that the only placebo-controlled trial showed no difference between vaccinated and placebo-injected infants . Clinicians can also emphasize that the benefits of vaccination extend beyond the individual child to protect vulnerable community members, framing vaccination as a civic responsibility as well as a personal health decision.

The Role of Healthcare Providers

Healthcare providers play a crucial role in vaccination decisions, as parents consistently rank their child's healthcare provider as the most trusted source of vaccine information . When providers recommend vaccines with confidence and take time to address parental questions, vaccination rates are higher than when providers avoid the topic or approach it hesitantly.

Dr. Sean McKenna emphasizes the importance of framing vaccination as both individual protection and community responsibility: "Taking care of our own health, and protecting the health of others, can and should be seen as a civic duty" . This framing acknowledges that vaccination is not merely a personal choice but a decision with implications for others, particularly those who are most vulnerable.

Conclusion

Childhood vaccination represents one of the most effective public health interventions in human history. The evidence base supporting vaccine efficacy and safety is robust, with systematic reviews consistently demonstrating that vaccines prevent disease with acceptable safety profiles . The public health impact has been profound, with routine immunization in the United States alone preventing over 500 million illnesses, 32 million hospitalizations, and 1.1 million deaths between 1994 and 2023 .

Despite these achievements, global vaccination coverage remains below target levels, with over 14 million infants receiving no vaccines in 2024 . Declining coverage in several countries has led to resurgences of vaccine-preventable diseases, most

notably measles, which has caused hundreds of cases and deaths in the United States alone . These outbreaks demonstrate the fragility of herd immunity and the importance of maintaining high vaccination coverage.

The legal and ethical dimensions of childhood vaccination raise complex questions about the balance between parental autonomy and children's rights to health protection. While parents traditionally have significant authority over their children's medical decisions, this authority is not absolute and must be exercised in accordance with the child's best interests . When parents refuse vaccination, they potentially expose their children to preventable harm and undermine community protection for vulnerable individuals.

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