A PUBLIC HEALTH EVALUATION OF EFFECTIVENESS OF VACCINATION PROGRAMS IN LOW – INCOME COUNTRIES

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ABSTRACT
When determining goals, deciding on regulations, and creating implementation policies for public health initiatives, there is a greater emphasis on taking the full public health value (FPHV) of vaccination into account. In order to evaluate safety and efficacy against etiologically established clinical outcomes, a therapeutic paradigm has historically been used to evaluate preventive vaccines. This paradigm centers on an individual benefit-risk assessment in prospective and individually-randomized phase III trials. A public health paradigm, in contrast, takes into account the effects on the population and includes metrics of community benefits in comparison to a variety of outcomes. A number of non-etiologically and etiologically defined clinical outcomes, such as health inequity, social and political disruption, disruption of household integrity, school absenteeism and work loss, health care utilization, long-term/ongoing disability, and the development of antibiotic resistance, may be included in the measurement of the FPHV of vaccination. From a public health standpoint, this study assesses how well immunization programs work in low-income nations. Despite significant global efforts to improve immunization coverage, many low-income nations continue to face challenges such as inadequate infrastructure, vaccine hesitancy, and financial constraints. The findings underscore the need for sustainable funding, community engagement, and strengthened healthcare systems to improve vaccine accessibility and coverage. This evaluation contributes to the broader discussion on achieving equitable healthcare and preventing vaccine-preventable diseases in resource-limited settings.

Keywords: *Public health, vaccination programs, low-income countries.*

INTRODUCTION

In the past, vaccinations have been evaluated for inclusion in public immunization programs based on their safety and effectiveness against major sequelae or severe etiologically verified disease. Numerous factors, such as age, geographic location, inclusion and exclusion criteria, diagnostic techniques, and epidemiological concerns, might influence the effectiveness of vaccines in randomized controlled trials. [1] These days, the majority of Indian youngsters live far healthier lives. Numerous vaccinations that target a variety of infectious diseases of worldwide public health significance have been produced in the past 20 years [12]. But in high-income nations, the list price of these vaccinations is significantly higher than that of conventional immunizations. As a result, governments and outside donors with limited funds frequently have to choose between funding other therapeutic and preventative measures and buying vaccines [9-11]. Along with other factors including efficacy, illness burden, and equality impact, evaluating the relative cost-effectiveness of competing treatments is a crucial part of adopting new health technologies in many high-income nations. [2] These studies often concentrate on the effects of vaccination on the health sector, balancing the expenses of an immunization program against the avoided morbidity and mortality as well as possible cost savings from lower health care consumption [13]. It has been proposed, meanwhile, that these cost-effectiveness studies can offer an overly limited view of the advantages of immunization and other child health initiatives [17]. This is especially true for many LMICs, where decision-making about health care spending is frequently based on broader development objectives rather than just health care-related concerns [18]. Additionally, a lot of these nations lack locally developed decision-making guidelines that would allow for the best possible distribution of resources within a set health care budget, thus broader factors like how vaccinations affect national finances or economic growth are frequently quite important. [3] The economic benefits of vaccinations have typically been quantified in terms of the avoided expenditures of medical treatment, in addition to their efficacy in lowering disease and mortality [14]. The immediate productivity loss to patients (due to illness or death) and their caregivers is occasionally taken into account as well. On the other hand, it has been proposed that vaccinations can boost lifelong productivity through improved physical health, a lower risk of cognitive impairment from certain diseases that can be prevented by vaccination, and improved educational achievements through higher attendance rates. Compared to their counterparts fifty years ago, there is less concern and anxiety among parents around their children's infections [16]. Child survival has increased as a result of creative and integrated approaches to child health care that have expanded the definition of a "healthy child" [19-20]. Reproductive, maternal, neonatal, child, and adolescent health programs (RMNCHA), including "immunization" of children, are given top attention in India's advanced health management systems. As one of the "10 Great Public Health Achievements" of the 20th century in the United States (US), vaccination comes in first place. Since its inception, vaccination has saved the lives of hundreds of thousands of children. We have successfully eradicated smallpox and, more recently, polio.

Over 14 million people worldwide lose their lives to communicable diseases each year, primarily in developing nations. Currently, the majority of disability adjusted life years (DALY) lost are caused by childhood infections such as measles, pertussis, and tetanus. Over 14 million people worldwide are killed by communicable diseases each year, primarily in low-income nations. The majority of DALYs lost are caused by VPDs that impact children, such as measles, pertussis, and tetanus. The prevalence of vaccination against the six primary VPDs varies by area in India, even with the availability of safe and effective vaccinations. In addition to boosting immunization coverage as recommended by the national immunization schedule, age-appropriate vaccine administration is crucial since it protects against disease at the highest risk [4]. Conventional health economic analyses simply take into account how actions affect the health care industry as a whole. However, other economic sectors like manufacturing, tourism, and transportation may be impacted by widespread illness outbreaks like cholera or pandemic influenza.

Literature review

Immunization is the process by which a vaccine is administered to a person, making them resistant or immune to an infectious disease. Vaccines stimulate the body's own immune system, protecting a person from future illness or disease. The only one that performs better is clean water, which is likewise regarded as a fundamental human right. [5] Immunization is widely recognized as the most effective single-child survival method to date. Immunization has significantly decreased child morbidity and death. Because vaccination has significantly decreased the burden of infectious diseases, it is both economically sound and meets the obligation to care for society's most vulnerable people. Furthermore, vaccination is a tried-and-true method of preventing and curing infectious diseases that pose a threat to life. It is one of the most economical health interventions made to date and is thought to prevent two to three million deaths annually. Its target populations are well-defined, outreach efforts can efficiently distribute it, and immunization doesn't necessitate significant lifestyle changes. Since it is a human right for everyone to have the chance to live a better and more fulfilling life, the international community has a moral duty to lower global child mortality by enabling universal access to safe immunizations. A comprehensive immunization program will lessen poverty and disparities and is the foundation of good public health. Beyond just preventing certain diseases in individuals, vaccinations can help societies and countries reap a wide range of benefits. This is due to the fact that immunizations can prevent the millions of children who die from VPDs. However, a person's "immunity" is fundamental to all of these illnesses and vaccinations [6]. The host's defenses against infection are humoral and cellular, systemic and local, and non-specific and specific. A period of passive immunity is passed from the mother to the kid through the placenta.

Over the course of six months, the newborn gradually loses the maternal antibodies that was transferred to them. As a result, many babies do not get serious infections for at least three months. There is strong evidence that the high levels of immunoglobulins IgM and particularly IgG in the cord blood and plasma of newborns born to immunological mothers are the cause of this protective "biological shield." Once microorganisms have gotten beyond local defenses, specific defenses are activated [7]. These defenses enable the host to identify, remove, and destroy antigenic material (such as bacteria, viruses, etc.) that is not his own. When a person has "particular protective antibodies or cellular immunity as a result of previous infection or "immunization" so to respond appropriately avoid infection, that person is considered immune. While passive immunity consists of non-human substances like Ig, certain human Ig, and animal antitoxins or antisera, active immunity consists of humoral immunity, cellular immunity, and a mix of the aforementioned [15].

Objectives

- To evaluate how well immunization programs work in low-income nations to lower the morbidity and death rates of diseases that can be prevented by vaccination.
- To analyze vaccination coverage rates and identify gaps in immunization efforts.

Research question

- How effective are vaccination programs in reducing vaccine-preventable diseases in low-income countries?
- How do vaccination programs impact public health outcomes, such as disease incidence and mortality rates?

Methodology

In active immunity, immunity is developed either by infection or by particular vaccination (agents) that stimulate an active immune defense mechanism by administering antigens, usually before an individual is

naturally exposed to an infectious organism. It can be accomplished via primary response or secondary response by the administration of a "Booster" dose. When the body uses exogenous animal or human antibodies to temporarily suppress disease, either shortly after or before exposure, passive immunity occurs since the body does not create its own antibodies. In contrast to active immunity, passive immunity is quickly developed, the immunity generated is only transitory (lasting a few days to months) until the antibody is removed from the body, and the reticuloendothelial system is not educated. These agents of immunization can be categorized as antisera, immunoglobulins, and vaccines. Data on pertinent vaccination components must be gathered and analyzed in order to improve the implementation of national vaccination programs.
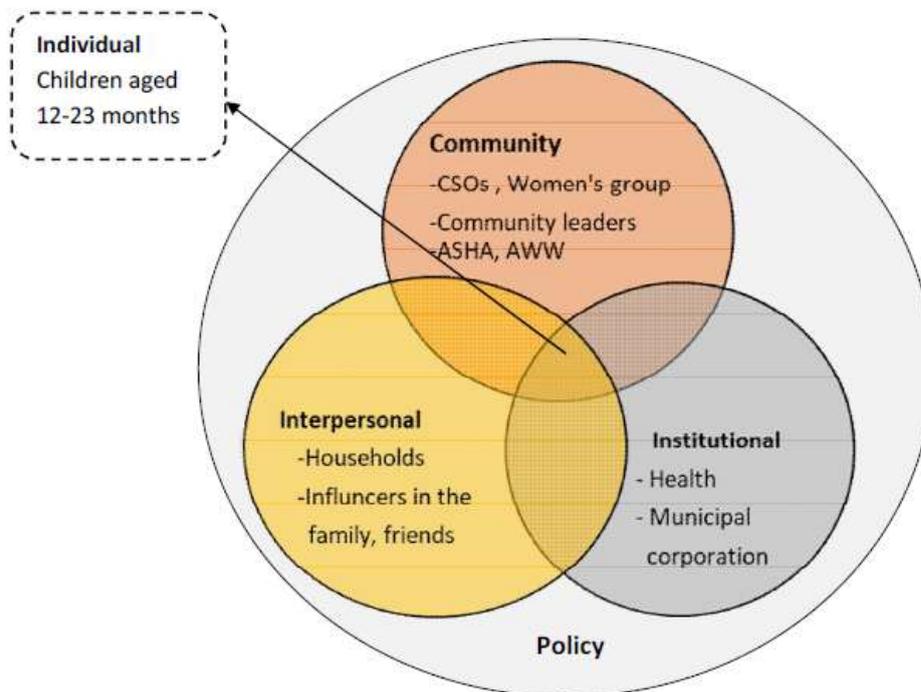
Figure 1: An ecological framework for guiding qualitative research method

By combining existing data on established indicators, benchmarked targets, and techniques for gathering, analyzing, and reporting the data required to improve immunization programs, monitoring and evaluation (M&E) or more recent Monitoring, Evaluation, Accountability, and Learning (MEAL) frameworks aid in decision-making. Pre-, peri-, and post-vaccination phases are typically included in M&E frameworks, which cover topics such as vaccine procurement, transportation, storage, staff training, communication, coverage, side effects, and identifying successes and failures. [8] Because of its impact on the pathogen-host ecology, vaccination is linked to positive externalities at the community level. For example, vaccination can reduce the risk of infection for those who are not vaccinated because they will no longer be susceptible to infection from vaccinated individuals (herd immunity). Antimicrobial resistance may be decreased by using vaccines to prevent the requirement for antimicrobials to combat afflicted organisms. Programs for vaccination may help increase the economics and long-term viability of healthcare in LMICs. Opportunities for cost sharing between programs are presented by their implementation in a treatment cluster or in conjunction with other infrastructure projects (like water management systems) to optimize community health results.

Experimental analysis
Findings from the qualitative research would be correlated with that of the quantitative approach. This will help to understand the overall problem and its solution in a better way. Table 1 shows the sampling design for the qualitative approach by the ecological model.

Table 1: Binomial Logistic Regression

	B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
What is the effectiveness of specific vaccines, such as measles, HPV, or pneumococcal conjugate vaccines, in low-income countries?	-.645	.416	2.412	1	.020	.524
How can vaccine hesitancy and refusal be addressed in low-income countries?	.432	.338	1.631	1	.202	1.541
What are the optimal vaccination schedules and strategies for low-income countries?	.192	.052	13.420	1	.000	1.212
How can vaccine supply chain and logistics challenges be overcome in low-income countries?	.268	2.089	.016	1	.898	1.307

The following outcome variables would be subjected to bivariate analysis: coverage of each primary vaccine, quality of vaccination, total dropouts, full immunization, partial immunization, and no immunization. A p-value of less than 0.05 would be regarded as significant for all statistical tests, including the t-test and the Chi Square test.

Table 2: Rotated Factor Matrix

	Factor		
	Health System Factors	**Political and Governance Factors**	**Economic Factors**
What is the cost-effectiveness of vaccination programs in low-income countries, and how can resources be optimized to achieve the greatest impact?	-.011	.889	.154
How do vaccination programs in low-income countries affect health outcomes, such as hospitalization rates, disease transmission, and economic productivity?	.085	.473	-.069
What are the key factors influencing vaccination coverage and effectiveness in low-income countries, and how can these factors be addressed?	.913	.205	-.069
How do immunization efforts affect the reduction of vaccine-preventable illness morbidity and mortality rates in low-income nations?	.802	-.150	-.158
How can vaccination programs in low-income countries be evaluated and monitored to ensure accountability, transparency, and continuous improvement?	.733	.282	.251

What is the impact of vaccination programs on reducing health inequities and disparities in low-income countries?	.221	-.598	.150
How can vaccination programs in low-income countries be strengthened to respond to emerging threats, such as pandemics and disease outbreaks?	.662	.453	-.593
What are the social and cultural factors that influence vaccine acceptance and uptake in low-income countries, and how can these factors be addressed?	.762	-.269	-.048
What is the impact of vaccine shortages or stockouts on vaccination coverage and effectiveness in low-income countries?	.014	-.051	.893

To create a final model, multivariate logistic regression analysis would be used to correct for any interactions and confounding variables. Multiple logistic regression analysis would take into account predictor variables with a p-value of less than 0.1 in bivariate analysis. The odds ratio (OR) and prevalence ratio (PR) with 95% CI would be used to explain the net bearing influence of various predictor factors.

Conclusion

These broader advantages of vaccination can be characterized using a number of recently developed frameworks. It's unclear, though, how much of these wider advantages are taken into account in the economic analyses of vaccines that are now being conducted. The purpose of this systematic review is to determine the degree to which current economic assessments of vaccinations in LMICs already account for broader economic advantages and to assess the reliability of the underlying methodology and related results used to estimate their impact. The impact of including these wider effects on healthcare program performance is examined through a narrative approach. Additionally, the possibility of including these effects in metrics that decision makers can understand when comparing ROI to ROI in other sectors is also explored. Because immunization programs can be incorporated into development projects, social activities like campaigns to reduce poverty, or combination treatment packages, they offer potential for cost-sharing and outside funding with other health and social interventions. Vaccination programs may help enhance supply chains and health care infrastructure, which might be leveraged for more public health projects. Vaccine demand may rise as a result of immunization campaigns. Some people may be able and willing to pay out of pocket to get vaccinated if the cost of purchasing the vaccine is subsidized, which would lessen the financial strain on the healthcare system.

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