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Review Article

A literature review on the economic benefits of vaccines in low and middle income countries: Evaluating progress in the era of '*a decade of vaccines*' initiative

Joseph D. Njau [a,*], Lisa K. Cairns [b]

[a] Division of Global Migration and Quarantine, National Center for Zoonotic and Emerging Infectious Diseases (NCZEID), Center for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA 30329, USA
[b] Division of Global Immunization, Center for Global Health, Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA 30329, USA

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ABSTRACT

While the clinical evidence of vaccine benefits is generally well established, the argument on the broader economic benefits resulting from investments in vaccines and immunization programs is murky and oftentimes, not well articulated. This is mostly true for low and middle-income countries. In this article, we examined literature evaluating both narrow and broad economic benefits of vaccines in LMICs from January 2000 to October 2016. A total of 177 studies were reviewed. Of these, 146 (82%) focused on understanding short-term direct and indirect impact (narrow economic benefits) of vaccines and 31 (18%) examined broader economic benefits which included willingness to pay for vaccines, outcome-related productivity gains, and savings accrued from preventing vaccine preventable disease (VPD) outbreaks. Virtually all studies reviewed concluded that implementation of various vaccine strategies were cost saving, cost-effective or, both cost saving and highly cost-effective under varying assumptions. The studies were further analyzed under three broad vaccine categories which included those focusing on new and underutilized vaccines 125 (71%), vaccines at the prequalification stage 31 (17%) and the traditional vaccines deployed through the Expanded Programme on Immunization such as pentavalent diphtheria-pertussis-tetanus, and those against polio, tuberculosis and measles which accounted for 21 (12%) of the studies. There was unequal geographic distribution of these studies when analyzed by World Health Organization regions. Regions like the Eastern Mediterranean and Europe had fewest studies completed (6) and (7) respectively. The lack of a standardized methodology and assumptions made cross-study comparisons and also broad generalization of some of the conclusions difficult. Most studies indicate that investments in immunization programs are cost effective and in some cases cost saving. Studies were skewed to narrow economic benefits. Wide variations in methods and assumptions made cross-country/study and regions comparisons difficult to achieve.

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* Corresponding author.
E-mail addresses: jnjau@cdc.gov (J.D. Njau), karenlisacairns@gmail.com (L.K. Cairns).

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1. Introduction

For decades, researchers and policy makers have strived to quantify the multi-dimensional benefits of vaccination programs [1–3]. Understanding both narrow and broad economic benefits of vaccines is important in assisting formulation of informed policies geared towards improved vaccination uptake [4–6]. It may also help to advocate for additional resources to sustain national immunization programs while accelerating the introduction and rapid scale-up of new vaccines especially those targeting children under-five years and those below 18 years.

Health ministries in low and middle-income countries (LMICs) as defined by the World Bank [7], are under increased pressure to improve the health of their populations. Health improvements can be achieved by addressing the burden of vaccine preventable diseases (VPDs) – the leading cause of child morbidity and mortality [8–10]. However, there is a heavy reliance on donor funding to support immunization programs in many LMICs [11–13], and a lack of understanding regarding the benefits of investing in vaccines and immunization programs [13–15]. Low investments in immunization programs especially in LMICs has in recent years resulted to sporadic outbreaks of VPDs such as measles, rubella, and rotavirus [16–19].

Understanding and quantifying the economic gains beyond health impacts that accrue from high vaccination coverage is important for pro-immunization policy formulation, advocacy, and resource mobilization [20,21]. Narrow economic benefits of vaccines is hereby defined as health gains quantified by reduction in morbidity and mortality; health care costs and loss of productivity avoided after introduction of vaccines to prevent widespread of VPDs. Meanwhile, the broad economic benefits is defined to include individuals' willingness to pay (WTP) for vaccines as implicit measure of value of life; increased productivity and GDP growth gained due to reduced burden of VPDs; behavioral related productivity gains resulting from improved child health and probability of survival; childhood improvement in physical and cognition developments; outbreak prevention savings, increased government revenues and health system strengthening resulting from investments and improvement of immunization programs.

Strategies to control vaccine-preventable diseases (VPD) with high economic and clinical burden can result to improved health equality and achieve healthier and more productive populations [22–25]. It can also allow diversion of resources to other public health problems including non-communicable diseases. Also, averting VPDs can help households avoid catastrophic medical expenditures [26,27], while affording family members more time for economically productive activities [28,29]. Consequently, vaccines can also reduce chances of long-term disabilities and childhood developmental delays due to VPDs. This has the potentially improve incomes, labor supply and productivity[29,30]. Overall, improved population health can contribute to micro-and macro-economic trajectories which can spur economic growth, as well as social and political stability [31,32].

For most LMICs with highest VPD burden, there is greatest uncertainty surrounding financing of immunization programs. Quantifying vaccine benefits is one of critical goals for achieving the Global Vaccine Action Plan (GVAP) objectives [33–35]. A synthesis on the evidence of the economic value of investing in vaccines with emphasis on the WHO recommended vaccines is completed in this review. The scope of past reviews has focused on one or, a few VPDs [36–43]. This review spurns from January 2000–October 2016 and includes a critical time in global vaccine initiatives following the adoption of the Decade of Vaccines (DoV) collaboration. The DoV's vision is to extend the full benefits of immunization to all people, regardless of where they are born, who they are, or where they live [44,45]. The timeline is also of significance importance following the ProVac initiative created in 2004. ProVac was started by the Pan American Health Organization (PAHO) with the goal to strengthen regional technical capacity to promote evidence-based decisions on new vaccine introduction with a particular focus on economic evaluations [46]. We also wanted to update the literature on the broader economic benefits of vaccines especially for the population aged below 18 years [47,48].

2. Materials and methods

We searched PubMed, Web of Science, Embase, EconLit and ABI/ProQuest for peer-reviewed articles published during 2000–2016. We used various MeSH terms including '"*Economics*' or *'Economic evaluation*, '*cost-effectiveness*' or '*cost-utility*' or '*cost-benefits*' or '*socioeconomics*' or '*Benefits*' or *'healthcare delivery'* or *'health systems' or 'willingness-to-pay'* AND *'Vaccine'* or *'Immunization'* AND '*low-and middle-income-country' or 'developing countries*'" to identify primary articles of interest.

After removal of duplicates, three stages were involved in the screening of relevant studies. First, we scanned article titles to determine their relevance for inclusion in the review. The preliminary exclusion screening criteria focused on titles that did not indicate an economic analysis of the benefits of vaccinations. The second stage of screening involved a review of study abstracts. Articles were excluded if the abstract indicated the study was completed in high income countries, was conducted before 2000, or did not address either the narrow or, the broad economic benefits of vaccines. This included both partial and full economic evaluation of various vaccines. The third and final screening involved a full review of the articles and abstraction of relevant information needed for the final analysis.

Following the three –pronged process, all remaining articles were compiled into an abstraction table. Studies were categorized based on their evaluation perspective which included government/provider, and household or societal costing perspective. Additionally, studies were grouped by the type of economic benefits covered (whether narrow and/or broad economic benefits), and the type of evaluation outcomes including disability-adjusted life years (DALYs) and quality-adjusted life years (QALYs). Additionally, findings from literature reviews were summarized and added into the references. All currencies except those on WTP studies were converted and inflated/deflated to 2013 US dollars [49,50]. We also abstracted information on overall study limitations. Using standard economic evaluation literatures [3,51,52], limitations including representativeness of vaccine antigens, methodological rigor, and geographic distribution of the completed studies were reviewed and reported.

The results of this study are organized into four broad categories. The first refer to regional distribution of the studies.