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# **WORKSHOP PRE-READING**

## **[ADVANCING THE VALUE OF VACCINES RESEARCH AGENDA]**

Summary of previous meetings, brief literature review, and participant survey



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## Introduction

The purpose of this paper is to summarize the past five years of research and thought leadership on the “broader” benefits of vaccination. Traditional economic assessments of the value of vaccination weigh the costs of vaccines (in terms of infrastructure, purchase, and delivery) relative to a handful of benefits – such as reduced and/or averted medical costs, increased health, and increased care-related productivity. This set of benefits is characterized as “narrow” because it does not account for the many social and economic benefits attributed – in part – to vaccination. Recent research quantifies these benefits and categorizes them as the “broader” benefits of vaccination. Ranging from increased and improved academic and professional performance to more stable societies, these benefits may accrue to

individuals, families, communities, and nations as a result of the preservation and promotion of health through the receipt of vaccinations.

Much more research has been done on a limited set of conventional vaccination benefits than on the broader benefits of vaccination. Evaluating the full impact of vaccination on economic growth and development has so far not been feasible. For policymakers, healthcare providers, patients, and manufacturers, deeper knowledge of the broader benefits of vaccination is critical for making evidence-based policies and creating robust programs to maximize health gains. This information is important for ministries of finance and health to enhance needed resource mobilization.

More robust research on these benefits has been hindered by the lack of large datasets containing health, education, labor, and economic data tailored to value of vaccination research. However, over the past decade, some key regional studies have contributed to the evidence base supporting the broader economic value of vaccination [1-5]. These studies explore a range of impacts - from improved educational attainment and cognitive development among children to sustainable tourism revenue and decreased government spending on outbreak control.

The following sections provide a comparison of prominent frameworks describing the value of vaccination, a summary of previous recommendations from meetings on the broader benefits of vaccination, a summary of a brief literature review on value of vaccination research from 2010 to present (including a sub-section focusing specifically on literature published since the last meeting), and a summary of survey results from researchers and stakeholders related to value of vaccination research.

## **Value of Vaccination Frameworks**

### *A comparison of the Bärnighausen et al. and Jit et al. frameworks*

Over the past ten years, a number of conceptual frameworks have emerged to index the broader benefits immunization programs can provide. These conceptual frameworks derive from a 2005 article by Bloom et al., which first made the case for considering the broader value of vaccination, emphasizing the symbiotic relationship between health and wealth [6]. Benefits described in this publication include cognitive development, educational attainment, labor productivity, income, savings, investment, and fertility. This was then developed in an initial framework by Bärnighausen and colleagues outlining three “narrow” benefits of vaccination (health gains, health care cost savings and care-related productivity gains) and three additional “broad” benefits (outcome-related productivity gains, behavior-related productivity gains and community externalities) [7]. Since then, this initial framework has been expanded and developed along a number of expansion paths (see Figure 2):

- The Harvard expansion: In 2014, Bärnighausen et al. published an update to their earlier framework outlining a number of additional broader benefits (community economic externalities and risk reduction gains) as well as moving health gains to the category of broader benefits (see Table1) [8].

**Table 1: Bärnighausen et al. framework [8]**

Perspective		Benefit categories	Definition
	Narrow	Health care cost savings	Savings of medical expenditures because vaccination prevents illness episodes
		Care-related productivity gains	Savings of patient's and caretaker's productive time because vaccination avoids the need for care and convalescence
Broad		Outcome-related productivity gains	Increased productivity because vaccination improves physical or mental health
		Behavior-related productivity gains	Vaccination improves health and survival, and may thereby change individual behavior, for example by lowering fertility or increasing investment in education
		Community health externalities	Improved outcomes in unvaccinated community members, e.g., through herd effects or reduction in the rate at which resistance to antibiotics develops
		Community economic externalities	Higher vaccination rates can affect macroeconomic performance and social and political stability
		Risk reduction gains	Gains in welfare because uncertainty in future outcomes is reduced
		Health gains	Utilitarian value of reductions in morbidity and mortality above and beyond their instrumental value for productivity and earnings

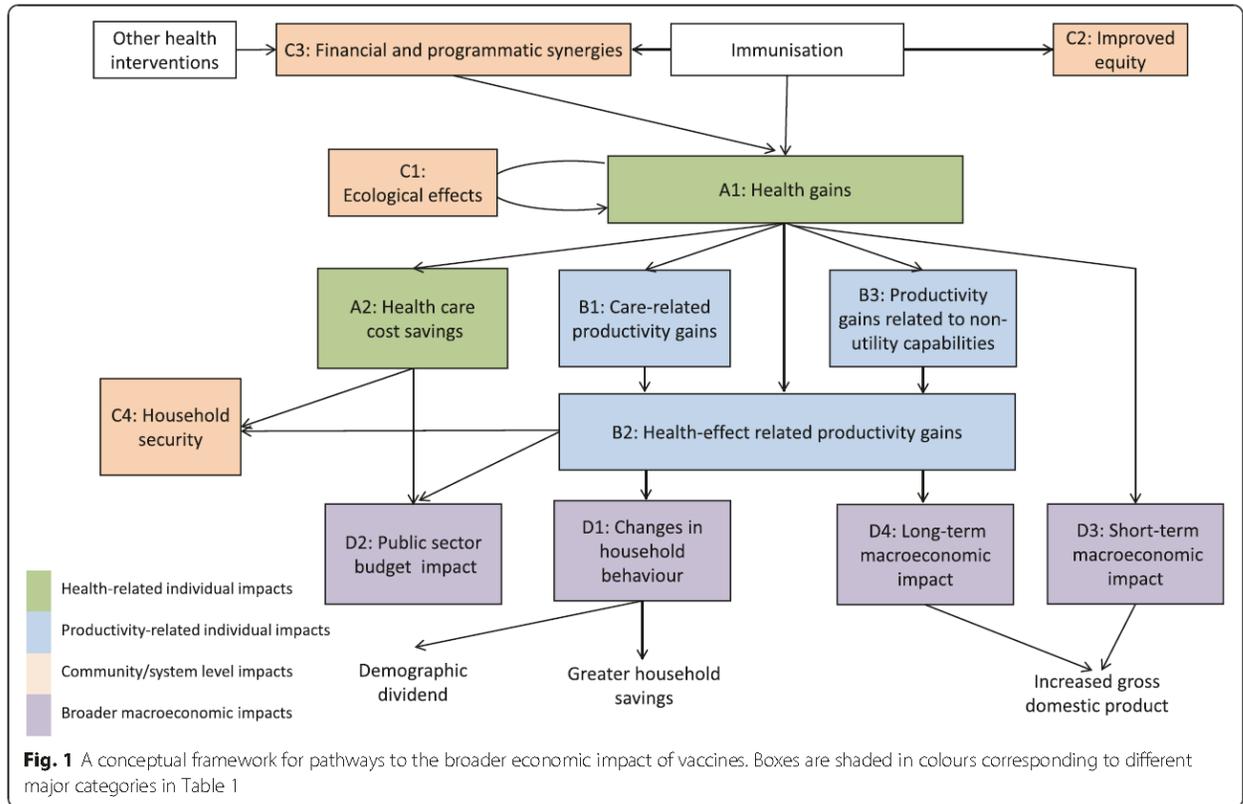
- The John Hopkins expansion: In 2012, Ozawa et al. published a systematic review of vaccine benefits which included an additional two categories of broader benefits (willingness to pay & value of statistical life, and outbreak prevention savings) [9].

**Table 2: Ozawa et al. framework [9]**

Perspective		Type of Benefit	Definition
Broad	Narrow	Health gains	Reduction in mortality or morbidity through vaccination presented in natural units of health <sup>a</sup>
		Health care cost savings	Savings of medical expenditures, health care system savings, and household savings because vaccination prevents illness episodes
		Care-related productivity gains	Savings of parents' productive time because vaccination avoids the need for taking care of a sick child
		Willingness to pay & Value of statistical life	Individuals or society's economic valuation of the long-term benefits from vaccination, including productivity gains and benefits of averting pain and suffering from vaccine-preventable diseases
		Outcome-related productivity gains	Increased productivity from averted mortality and morbidity, including the productivity benefits from improved cognition and physical strength, as well as school enrollment, attendance and attainment
		Behavior-related productivity gains	Benefits accruing because vaccination improves child health and survival and thereby changes household choices, such as fertility and consumption choices
		Outbreak prevention savings	Benefits accruing to society from saved costs of outbreak investigations and prevention

- The World Health Organization (WHO) expansion: WHO organized a series of international expert consultations between 2011-2014 [10] and was involved in a systematic review by Deogaonkar et al. [11]. An expanded framework was developed based on the original (2008) Bärnighausen et al. framework, the Ozawa and Deogaonkar reviews and the expert consultations. In 2015, the framework was published alongside a delineation of the potential causal pathways for different benefits, and a review of the strength of evidence behind each pathway [7].

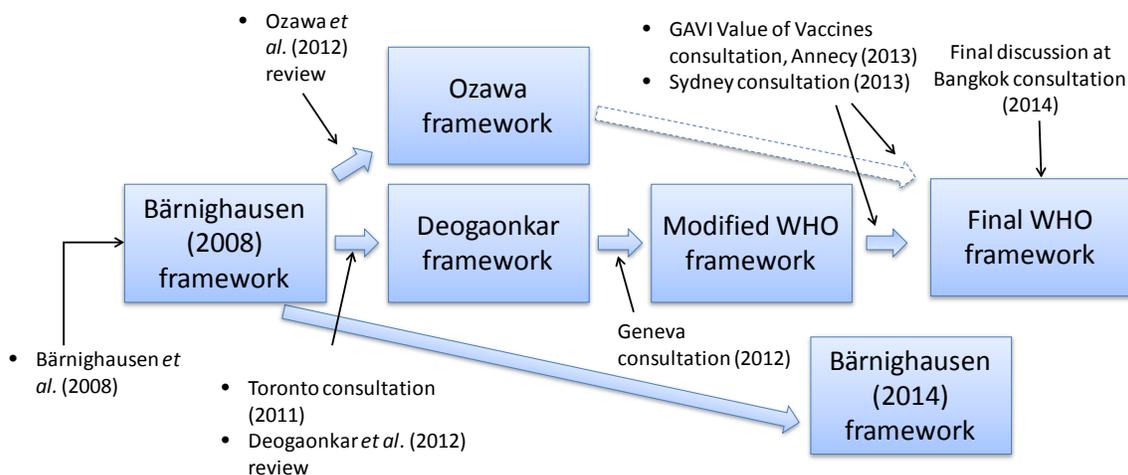
**Figure 1: Jit et al. framework [10]**



While these frameworks have much in common, there are some important differences that warrant discussion. Bärnighausen et al. describes benefits from risk reduction, including “gains in welfare because uncertainty in future outcomes is reduced” [8]. This benefit has not been comprehensively addressed in the Jit et al. framework, although protection from financial risk is captured. Additionally, the Bärnighausen et al. framework will soon include information on further community health externalities and health gains related to the benefits of childhood vaccination for secondary unvaccinated populations such as the elderly (a more specific type of indirect effects), and the potential benefits of “non-specific effects” as the body adapts to new vaccine-induced immunities. It is worth noting that more research is needed to understand the nature of non-specific effects, and in which contexts they are likely to be harmful or advantageous [12].

## Figure 2: Relationship of the framework with previous lists of categories of broader economic impact of vaccination and immunisation programmes

Figure from Additional File 2 of the source article [10].



### Table 3: Framework comparison

The table below matches the categories of benefit between the two frameworks to highlight their similarities and differences.

Bärnighausen et al. framework, 2014	Jit et al. framework, 2015
Health care cost savings	Health care cost savings
Care-related productivity gains	1. Productivity gains related to care 2. Productivity gains related to health effects
Outcome-related productivity gains	Productivity gains related to non-utility capabilities <sup>1</sup>
Behavior-related productivity gains	Changes to household behavior
Community health externalities	Ecological effects
Community economic externalities	1. Household security 2. Short-term macroeconomic impact 3. Long-term macroeconomic impact
Health gains	Health gains
Risk reduction gains	Partially captured in 1. Household security
N/A	Equity
N/A	Financial and programmatic synergies and sustainability
N/A	Public sector budget impact

<sup>1</sup> Refers to capabilities that may be measured in terms of educational and cognitive outcomes, and potential lifetime earnings.

The Jit et al. framework explicitly credits vaccines with improving the equitability of health outcomes, strengthening other health platforms (such as pooled procurement), and having positive lifetime net tax implications for the public sector. These vaccine benefits have not been directly addressed in the Bärnighausen et al. framework. With regard to the economic impacts of vaccination, the Jit et al. model more clearly distinguishes between the micro- and macro-economic impacts, while the Bärnighausen et al. model groups these as community economic externalities.

It is important to note that both of these frameworks should be considered evolving models to be updated as research and thought leadership on the value of vaccination grow more capable of capturing the full benefits.

## **Where have we been?**

### *A synthesis of recommendations from previous workshops*

At the first value of vaccination conference in Toronto in 2011, the Bärnighausen et al. framework was presented. Workshop participants recommended that at minimum, the categories of benefits listed in the Bärnighausen et al. framework<sup>2</sup> should be considered for inclusion in economic evaluations of vaccines. Participants also discussed a series of interviews and surveys that had been conducted to better understand how key stakeholders evaluated vaccines and which benefit categories these stakeholders considered most important [13].

At the Geneva workshop the following year, the Bärnighausen et al. value of vaccination framework was updated based on an online survey (n = 26) and additional interviews (n = 14) with key stakeholders [14]. These interviews revealed that stakeholders viewed sectoral gains (also referred to as macro-economic impact), burden of disease, ecological externalities and outcome-related productivity gains as the most important impacts of vaccination [15]. Behavior-related productivity gains and other externalities were not considered important vaccination-related gains. However, there may be selection bias in these responses due to the low response rate. Of the 150 people who received the survey, only 26 completed it.

Based on a review of studies that tried to capture the broader economic impact of vaccination in low- and middle-income countries, workshop participants recommended that the existing framework be organized into three categories: health-related benefits, productivity-related benefits, and community externalities. Health-related benefits are supported by the largest evidence base, and an increasing number of studies measure productivity-related benefits. However, few studies investigate community externalities as a result of vaccination.

Participants also discussed a number of good practice guidelines to better capture the impact of vaccination. These include ensuring that the research is transparent, evidence-based, suitable to the audience of interest, and feasible in terms of expense and time. Other major recommendations include continuing research efforts to better understand the drivers of decision-making among stakeholders,

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<sup>2</sup> Health gains, health care cost saving, care-related productivity gains, outcome-related productivity gains, behavior-related productivity gains, and community externalities

using randomized controlled trials to strengthen evidence behind causal links in the framework, and assessing the economic implications of congenital rubella syndrome.

The 2013 meeting in France created several overarching recommendations in addition to specific short-, medium-, and long-term recommendations. The overarching recommendations are to encourage studies that enhance understanding of value of vaccination research methodologies; evaluate the broader and long-term impacts of vaccination by measuring additional health, economic, and social outcomes; and analyze variations in the costs of vaccines and vaccination delivery programs. In the short-term, there is a need for additional data sources and research agendas that focus on impact evaluation and new vaccine introduction. Medium-term recommendations encourage data collection on the value of statistical life, willingness to pay, and disease burden in low resource settings. Long-term goals include collecting prospective data alongside new phase III and IV vaccine trials and “explor[ing] intermediate biomarkers to outcomes of disease and vaccination” [16].

The primary recommendations from the 2014 Bangkok meeting were to conduct a literature review on the duration of disease sequelae and disability by country and to perform econometric analyses on direct non-medical and indirect costs of vaccine-preventable diseases. A further recommendation was to create a standardized manual for evaluating the social and economic impacts of vaccination. Participants also proposed that data and results from future studies be geared towards the key decision-makers in each scenario, particularly those involved in policy [17].

## **Where are we?**

### *Summary of key research from 2010-2015*

A brief literature search was conducted using the search terms detailed in Table 6 (see page 15). These search terms were designed to capture all studies that discuss the impacts, benefits, or costs of specific vaccines or immunization programs or of vaccination in general. The goal of this search was to determine the state of the literature on the broader value of vaccination. The search identified 25 papers that have been published on these broader benefits since 2010. Thirteen of these studies focus on a specific vaccine or immunization program, such measles or malaria vaccination. The remaining 12 describe the broader benefits of immunization in general and why they should be accounted for in economic evaluations. In the same time period, hundreds of cost-benefit and cost-effectiveness papers focusing almost exclusively on health care cost savings of vaccines have been published.

Of the 25 papers, all account for health care cost savings, and the majority include outcome-related productivity gains, care-related productivity gains, community health externalities, and health gains. However, fewer than half of the papers discuss health gains, behavior-related productivity gains, non-health community externalities, or risk reduction gains. Even within the broader value of vaccination literature, not all evaluations include the costs associated with all of the categories in the Bärnighausen et al. framework.

**Table 4: Benefits categories listed in literature review results**

<b>Benefit Category<sup>3</sup></b>	<b>Percentage of studies including this benefit</b>
Health care cost savings	100% (25 of 25 studies)
Outcome-related productivity gains	96% (24 of 25 studies)
Care-related productivity gains	80% (20 of 25 studies)
Community health externalities	68% (17 of 25 studies)
Health gains	56% (14 of 25 studies)
Non-health community externalities	44% (11 of 25 studies)
Behavior-related productivity gains	36% (9 of 25 studies)
Risk reduction gains	28% (7 of 25 studies)

Between 2010 and 2016, little has changed in terms of the recommendations given in scientific literature to evaluate the full impact of vaccination. Many of the authors of the studies included in this review suggest that all researchers use one of the value of vaccination frameworks in their economic analyses, yet few have chosen to do so. As is reflected by the meeting recommendations from 2011-2014, it is crucial that key stakeholders understand these frameworks so that their decisions can be made based on a more complete evaluation of the impact of immunization. However, few of the papers found in the literature search described in this paper are directed at a specific audience or explain how the framework should be used by policy makers, finance ministers, or other important stakeholders. The majority of the studies conclude that more data are needed to strengthen the evidence supporting the framework.

In order for these data to be collected, top-down change needs to occur within national and international regulatory agencies so that the parameters of future research include data collection and analyses on these expanded benefits. This change is predicated upon greater comprehension of broader benefits frameworks in the highest levels of national and international health policy. Decision-makers need a deeper comprehension of these frameworks so that the body of literature will grow in response to the top-down demand for this type of research. A cohesive set of guidelines for future economic evaluations will be a critical next step in helping to increase the quality and quantity of literature on the value of vaccination.

### **Review of key literature since the last meeting**

Although frameworks on the value of vaccination have not changed radically over the past several years, it is still worth examining the key trends that have emerged in the relevant literature since the 2014 Bangkok meeting.

Recent articles highlight the important gains in schooling and cognition that may result from childhood vaccination, particularly when the child is vaccinated before 12 months of age [4, 18]. In 2015, both Anekwe et al. and Driessen et al. found that higher measles vaccination coverage leads to

<sup>3</sup> Categories from the Bärnighausen et al., 2014 framework

higher school enrollment and educational attainment [4, 18]. Notably, Anekwe et al. reported that for every five to seven children that receive measles immunization before 12 months of age, one additional year of schooling was gained due to decreases in the long-term sequelae of measles and their associated social impacts [18]. These significant findings highlight the key role of vaccination in improving future productivity and income through education. This research represents a step in the right direction to establish a causal relationship between immunization, education, and productivity.

As evidence for the importance of vaccination has accumulated, a number of authors have called for greater implementation of value of vaccination frameworks by government officials and other professionals who must determine how to best allocate public resources for health and social welfare [19-21]. Along those lines, some authors have suggested that frameworks intended for government officials should attempt to account for increases in future tax revenue that may result from averted mortality and increased productivity [20, 21]. These tax gains may be quite large. One cost-benefit analysis found that for each Euro invested in HPV vaccination, the government is returned €1.7 from a combination of saving on HPV-related medical expenses and averting tax revenue losses due to premature mortality [21].

The need to develop clear tools and methods of evaluation for decision-makers who are interested in adopting a broad values perspective has also emerged in the recent literature. One paper recommended using an operations research approach in the form of multi-criteria decision analysis (MCDA). This type of analysis lends itself well to vaccination evaluations because it can compare numerous metrics, preferences, and priorities from different stakeholders, in addition to being a widely accepted tool in the field of healthcare [22]. Frameworks customized for different audiences and uses should be created to increase the inclusion of the broader values of vaccination in all sectors.

Recently, other researchers have focused on the health equity benefits of vaccination. Widespread access to vaccination programs may increase health equity –an increasingly important objective in the field of public health [23]. Few vaccine-preventable diseases are attributable to health behaviors at the individual level; instead, their distribution is largely socially determined [23]. Vaccination can be a powerful tool to reduce the disease burden overall, and especially for the most vulnerable. When designing vaccination programs, it is critical to ensure equitable uptake among an entire target population to avoid unintentionally intensifying inequities by letting the health benefits accrue to only those with greater access to health resources [10].

For populations that experience particularly high levels of disease, targeted vaccination programs are not without controversy. Targeted vaccination campaigns may appear discriminatory when directed toward populations struggling with high levels of social stigma, such as commercial sex workers, men who have sex with men, and migrant populations [23]. Protecting the public health of all populations should be done in a way that does not support marginalizing stereotypes that reinforce blaming individuals for disease transmission [23]. The equity-promoting potential of vaccination should be leveraged and incorporated into benefit frameworks for social policy development.

## Where are we going?

### *Recommendations for the future*

To gain further insight into current value of vaccination research and how to expand it, vaccine experts and value of vaccination stakeholders were surveyed. A six-question online survey was sent to 75 experts, of whom 26 responded and 23 completed the entire survey (see Table 5 for the list of questions and common responses). Due to self-selection of the respondents and the relatively low response rate of 35%, some biases may be present. The survey was comprised of six open-ended questions that examined the opportunities and challenges for research on the value of vaccination, ongoing value of vaccination research, and the most important areas of research to be addressed going forward. Survey responses were analyzed to determine common themes, ascertain the most significant opportunities for – and barriers to – research on the value of vaccination, and to identify important topics and strategies for future research.

Several common problems and recommendations for value of vaccination research are described in the survey responses, value of vaccine literature from the last several years, and publications from previous workshops. Many experts in this field of research emphasize the need for more data sources that can be used in research on the value of vaccination. The economic data necessary for analysis are often unavailable or unsuitable for this type of research due to privacy concerns. Where data do exist, they are often not used to their full potential for research. Developing innovative approaches to the analysis of existing datasets or linking health and non- health datasets would facilitate further research.

A second common theme is the need for a more clear research agenda and priority list to advance research on the value of vaccination. Although numerous fragmented recommendations have been made, research priorities for the field of value of vaccination research as a whole are unclear. Setting common goals and identifying steps in the research process will enable more collaboration among investigators and hasten the progression of research.

Another concern across all stakeholders is the lack of standardized methods or tools for evaluating the value of vaccination. In the current value of vaccination literature, numerous methods, models, and indicators are used, and these are often quite complex. Standardized tools should not only help researchers and other experts in the field assess the social and economic impacts of vaccination, but should also be geared towards policymakers, people in government, and researchers in other non-vaccine-related areas of study. While it is certainly important for vaccine researchers to understand the various types of benefits resulting from immunization, it is just as crucial that they are easily understood by those who make decisions about vaccine policies and programs. This will help to ensure that the broader value of vaccination is taken into account in more health and vaccination analyses. It will also facilitate collaboration between value of vaccination researchers and decision-makers in other areas.

Across the recommendations from previous meetings, literature, and survey responses it was clear that the community of stakeholders for value of vaccination research need to coalesce around common investigation priorities, study methods, and tools to apply the evidence to real-world decision-making.

**Table 5: Survey results**

<p><b>(1) What are the opportunities for research on the value of vaccination?<sup>4</sup></b></p> <ul style="list-style-type: none"><li>• Measure economic impact (11)<ul style="list-style-type: none"><li>• Economic growth</li><li>• Educational attainment</li><li>• Productivity gains</li></ul></li><li>• Identifying new opportunities for data analysis (9)<ul style="list-style-type: none"><li>• Adding questions about economic impact or long-term follow-up to vaccine control trials</li><li>• Innovative analysis of existing datasets/linking health with non-health datasets</li></ul></li><li>• Measure health benefits that accrue to vaccinated party (8)<ul style="list-style-type: none"><li>• Averted cases</li><li>• Cognitive ability</li><li>• Immune training</li><li>• Increased effectiveness of childhood nutrition interventions</li></ul></li><li>• Spillover health effects (5)<ul style="list-style-type: none"><li>• Herd immunity</li><li>• Antibiotic resistance</li><li>• Pathogen ecology</li><li>• Serotype replacement</li></ul></li></ul>
<p><b>(2) What are the challenges for research on the value of vaccination?</b></p> <ul style="list-style-type: none"><li>• Insufficient data/experimental evidence (11)<ul style="list-style-type: none"><li>• Specific economic data not always available<ul style="list-style-type: none"><li>• E.g., workplace absenteeism</li></ul></li><li>• Privacy concerns with infectious disease data</li></ul></li><li>• Difficulty of identifying proper analytical techniques and lack of standardized methodology and measures (9)<ul style="list-style-type: none"><li>• Difficult to control confounding</li><li>• Forecasting is an unproven art</li><li>• Much of the evidence is conjectural</li></ul></li><li>• Ethical concerns with experimentation</li><li>• Time gap between immunization and certain vaccine effects (8)<ul style="list-style-type: none"><li>• Pathogen ecology/serotype replacement</li></ul></li></ul>

<sup>4</sup> The original survey questions contained the wording “value of vaccines” versus “value of vaccination.” Based on feedback in the workshop, this phrasing has been updated when appropriate in all workshop documents.

- Delayed complications – e.g., paralysis
- Herd effects
- Immune training effects
- Unexpected benefits
- Lack of stakeholder awareness and/or interest (6)
  - Shifting research priorities
  - Resistance of manufacturers to trial add-ons

**(3) Please list what you believe to be the three biggest reasons why more research is not being done on the value of vaccination.**

- Lack of awareness and/or interest in vaccines and vaccine research from funding bodies/stakeholders (11)
  - Researchers and funders do not always perceive a need for VoV research
  - Manufacturers can be hesitant to add VoV research onto trials
- Concerns with methodology for evaluating value (9)
  - Lack of standardized methods
  - Propensity for relying on overly-complex models
  - Narrowly-focused indicators
  - Methodology does not always factor in drawbacks
- Insufficient data (6)

**(4) Please let us know any other thoughts you wish to share on the current state of research on the value of vaccination.**

- Call for more collaborative research – both within the arena of VoV and between VoV research and other health research priorities (4)
  - Shared approaches, definitions, and frameworks for VoV research
  - Consider effects of vaccines along with other health interventions

**(5) Please list any ongoing research on the value of vaccination, including economic benefits, of which you are aware.**

**Vaccines & pathogens**

Zika, Dengue, HPV, Meningitis B , PCV , Rotavirus

**Vaccination strategies & target populations**

- Meningococcal outbreaks
- Measles supplementary immunization activities (SIAs)
- Pediatric flu vaccination
- Respiratory syncytial virus (RSV) vaccine (maternal)

- Maternal pertussis vaccination

### **Vaccine effects**

- Economic impact
  - Economic impact assessments of specific vaccines and/or pathogens
  - Outbreaks
  - Live vaccines – accounting for both specific and non-specific effects
  - Return on investment for childhood immunization
  - Costs of illnesses associated with vaccine preventable diseases in LMICs
  - Direct and indirect medical costs
  - Extended cost-effectiveness analysis
  - Financial risk protection
  - Traditional cost-effectiveness
- Health impacts modeling
- Equity
  - Mediation of socioeconomic inequalities in child mortality
- Health system strengthening
- Impact of vaccine interventions on hospitals' Quality of Care (QoC) scores
  - Childhood vaccines and elderly vaccines
- Absenteeism of working mothers
- Deaths and disease averted in the decade of vaccines and beyond
- Spillover effects of HPV vaccine on HIV acquisition
- Educational attainment

### **Organizations, projects, and data sets**

- India Human Development Survey (IHDS)
- International Decision Support Initiative (IDSI)
- Decade of Vaccines Economics (DOVE),
- Johns Hopkins University
- Harvard University
- Aga Khan University
- Agence de Médecine Préventive (AMP)
- Oxford University
- Emory University
- Manhica Health Research Center (CISM)
- World Health Organization

### **Geographical settings**

- India

- Netherlands
- Burkina Faso
- Nepal
- Kenya
- Mozambique
- Belgium
- South Africa

### **Decision-making and VoV**

- Best-worst scaling on the importance of having VoV information available during the decision-making process
- Case study on HPV introduction to see if and how VoV is included in decision-making process and its role relative to other economic information
- Assessing the approach of optimization modelling
- Return on investment analysis methods

### **(6) What are the top three research questions that need to be addressed related to the value of vaccination?**

- Need for quantitative evaluations of system- or population-level effects of vaccines (15)
  - Overall economic growth
  - Health and economic equity
  - Fertility rates
  - Impact of vaccine delivery on health systems
- Need for quantitative assessment health and economic effects – beyond averted cases/mortality – at the individual or family level (11)
  - Connection between vaccination and education
  - Childhood/cognitive development
  - Non-specific immunological effects/immune training
  - Likelihood to adopt other preventive measures
- Need to develop standardized metrics and methodologies for VoV assessment (6)
  - Measuring values other than financial values
  - Agreement on ranking of indicators
  - Metrics and methods need to be flexible enough to be used in different contexts (e.g., geographical regions, high-income vs. low-income countries, etc.)

**Table 6: PubMed, EMBASE, and Web of Science search strategies for the broader social and economic impacts of vaccination**

*See references [1, 2, 4, 10, 11, 18-37] for the citations of studies included in the literature review*

<b>DATABASE</b>	<b>PubMed</b>
<b>STRATEGY</b>	<b>#1 AND #2 AND #3 AND #4 AND #5 AND #6 AND #7 AND #8 AND #9 AND #10 AND #11 AND #12</b>
#1	(vaccin*) AND (broad* benefit)
#2	((vaccin*) AND (social benefit))
#3	((vaccin*) AND (social impact))
#4	((vaccin*) AND ("social implication"))
#5	((vaccin*) AND ("societal implication"))
#6	((vaccin*) AND ("economic benefit"))
#7	((vaccin*) AND ("economic impact"))
#8	((vaccin*) AND ("economic implication"))
#9	((vaccin*) AND ("community external*"))
#10	((vaccin*) AND (productivity))
#11	((vaccin*) AND ("return on investment"))
#12	((vaccin*) AND ("extended cost effectiveness analysis"))
<b>DATABASE</b>	<b>EMBASE</b>
<b>STRATEGY</b>	<b>#1 AND #2 AND #3 AND #4 AND #5 AND #6 AND #7 AND #8 AND #9 AND #10 AND #11 AND #12 AND #13</b>
#1	vaccin* AND broad* AND benefit
#2	vaccin* AND social AND benefit
#3	vaccin* AND social AND impact
#4	vaccin* AND 'social implication'
#5	vaccin* AND 'societal implication'
#6	vaccin* AND 'economic benefit'
#7	vaccin* AND 'economic impact'
#8	vaccin* AND 'economic implication'
#9	vaccin* AND 'community external'
#10	vaccin* AND productivity
#11	vaccin* AND 'return on investment'
#12	vaccin* AND 'extended cost effectiveness analysis'
<b>DATABASE</b>	<b>Web of Science</b>
<b>STRATEGY</b>	<b>#1 AND #2 AND #3 AND #4 AND #5 AND #6 AND #7 AND #8 AND #9 AND #10 AND #11 AND #12 AND #13 AND #14 AND #15</b>

#1	(TS=(vaccine AND broad* benefit))
#2	(TS=(vaccination AND broad* benefit))
#3	TS=("value of vaccine")
#4	TS=("value of vaccination")
#5	TS=((vaccin*) AND ("social benefit"))
#6	TS=((vaccin*) AND (social impact))
#7	TS=((vaccin*) AND ("social implication"))
#8	TS=((vaccin*) AND ("societal implication"))
#9	TS=((vaccin*) AND ("economic benefit"))
#10	TS=((vaccin*) AND ("economic impact"))
#11	TS=((vaccin*) AND ("economic implication"))
#12	TS=((vaccin*) AND ("community external*"))
#13	TS=((vaccin*) AND (productivity))
#14	TS=((vaccin*) AND ("return on investment"))
#15	TS=((vaccin*) AND ("extended cost effectiveness analysis"))

## References

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