



Tracking donor funding towards achieving the Global Vaccine Action Plan (GVAP) goals: A landscape analysis (1990–2016)



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ABSTRACT

Efforts driving universal coverage have recently been strengthened through implementation of the Global Vaccine Action Plan (GVAP) where cost estimates for immunization support were developed totaling US \$40 billion of donor assistance by 2020. In addition to resource mobilization, there has been an increasing focus on improving both vaccine access and delivery systems. We track donor assistance for immunization by funding objective and channel from 1990 to 2016, and illustrate projections through 2020 to inform progress of the GVAP.

Using available data from development agencies supporting immunization, we categorize funding by vaccine and quantify support for systems strengthening. We split time into four periods including the post universal childhood immunization era (1990–1999) and Gavi's three funding phases between 2000 and 2015, during which annualized funding changes are estimated. Lastly, we perform a linear extrapolation through 2020 to predict the success of stipulated resource mobilization targets. Double counting was eliminated and results presented in real 2017 US dollars.

Over the last 27 years, funding for immunization increased by 10.5% annually, with non-Gavi funding increasing by 7.1% and Gavi funding by 23.6% in the last 17 years. Gavi disbursements targeting vaccines and health system improvements increased uniformly at 15%, compared to 22.5% for vaccines and 11.7% for system strengthening from non-Gavi channels. Funding fluctuated for non-Gavi channels with disbursements declining before 2000 and during Gavi funding phase II, while Gavi disbursements continued to grow relative the previous phase. New and underused vaccines were prioritized by Gavi whereas non-Gavi channels focused on elimination efforts. Projected funding targets were estimated to be on track for Gavi contrary to non-Gavi support which was estimated to remain 40% below the stipulated target.

Renewed assessments for funding requirements need to be undertaken, while strengthening existing resource efficiencies in order to achieve current global universal coverage targets.

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1. Introduction

Global efforts towards achieving optimal universal immunization coverage have evolved since the introduction of the Expanded Programme on Immunization in 1974 [1], an initiative of the World Health Organization (WHO). Subsequent initiatives include Gavi, the Vaccine Alliance in 2000, the Global Immunization Vision and Strategy in 2006 and more recently the Global Vaccine Action Plan (GVAP), a multi sectoral initiative launched in 2012 [2].

The GVAP was approved by 194 Member States of the World Health Assembly in 2012 specifying renewed and targeted strategies towards achieving universal vaccination coverage by 2020. Development and implementation of GVAP has involved multiple stakeholders comprising governments, professional institutions, academia, manufacturers, global agencies, development partners, civil society, media and the private sector with designated responsibilities monitored collectively through a coordinated mechanism. The plan describes potential health returns on investment in immunization using vaccine coverage and child mortality as target outcomes. Specific goals resulting from this investment included reductions in childhood deaths, meeting set elimination targets, improving coverage for both routine and newly introduced vaccines at both national and subnational levels, and fostering up to five

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additional vaccine introductions among low and middle income countries by 2020. Substantial progress has since been made [3] mainly regarding new vaccine introduction particularly among Gavi eligible countries, and in case containment and reduced transmission of polio. However, elimination efforts towards tetanus and measles and current coverage estimates for both new and routine vaccines still fall below the intended targets. Resource estimates towards implementation were developed based on analyses restricted to low and middle income countries [4] aimed at scaling up and sustaining both current routine immunization and supplemental activities in order to reach elimination and eradication goals. Costs were informed using both planned vaccine introductions and scale up over 10 years totaling \$40 billion of donor assistance by 2020. Of this, \$12 billion was stipulated to be channeled through Gavi the Vaccine Alliance, and \$28 billion through other development agencies and organizations.

In addition to resources specific for commodities such as vaccines and vaccine supplies, additional investments have been made targeting particular processes through which service delivery is optimized. For example, development assistance for health (DAH) specific to immunization has been disaggregated to include support for health system strengthening activities [5] aimed at addressing any existing bottlenecks along the chain of immunization delivery as well as vaccine support. Where funding support can be distinguished by purpose, resource tracking within the given categories over time for different programs provides an opportunity to accurately describe investment flows, and estimate their potential impacts. Distinguishing between support for new and underused vaccine availability and support for activities aimed at addressing health system constraints will be useful in understanding resource area gaps within the immunization program in order to further guide planning and targeted spending processes.

Expenditure tracking over time has been performed for overall assistance for health [6,7] by funding channel [8,9], and by program area such as maternal and child health [10,11]. Similar work on immunization has focused on tracking overall aid for immunizations with an emphasis on donors to recipient flows [12]. In order to characterize development assistance for immunization, we track aid for immunization by channel assessing trends of Gavi and non-Gavi support from 2000 to 2016, and 1990 to 2016 respectively. Non-Gavi channels comprised all other aid agencies that provided development assistance for immunization outside Gavi including UNICEF, the World Health Organization (WHO), private philanthropies and development banks, among others. We categorize aid into funding for procurement of vaccine and vaccine supplies, and funding for health system strengthening for the immunization program. In addition, we examine trends of support at specific time points starting in the period 1990–1999 (post universal childhood immunization), and during the first three 5-year funding periods of Gavi representing fundraising processes including 2000–2005 (phase I), 2005–2010 (phase II) and 2010–2015 (phase III). We incorporate an additional time category representing Gavi phase IV which together with phase III straddles the GVAP timeframe to measure progress towards projected funding targets between 2011 and 2020 from both Gavi and other channeling agencies. This updated and comprehensive assessment of immunization program support provides evidence against which development assistance partners can track their progress and make informed strategies to achieve universal access to immunization.

2. Methodology

Project-level disbursement data by expense year from Gavi were obtained from the Gavi website [5] spanning 2000 to 2016. Data were available for different programs supported at country

level for each year funds were disbursed, including categories to which funding was allocated. These included cold chain equipment optimization platforms (CCEOP), civil society organizations (CSO), cash support, Ebola EPI recovery plan, graduation grants, health systems strengthening (HSS), Injection safety support (INS), Immunization system strengthening (ISS), investment cases, new vaccine support (NVS), operational support, product switch grants, and vaccine introduction grants. Based on the specific objectives for each of these programs, we re-classified financial data into ‘vaccine support’ (cash support, NVS, vaccine introduction grants, product switch grants, and investment cases), and ‘health systems strengthening (HSS) support’ (CCEOP, CSO, HSS, ISS, operational support, graduation grants, and epidemic recovery grants).

Disbursement data from non-Gavi funding channels were obtained from the development assistance for health (DAH) database compiled by the Institute for Health Metrics and Evaluation (IHME). The database contains updated estimates of DAH by funding source (donor), channel, health focus area, and where possible, recipient location [6]. The data are typically compiled using revenue and expenditure data from online project databases, financial statements, budgets, audited reports and through correspondence where data are not publicly available [7]. The database includes data from bilateral agencies which comprise 23 OECD (Organization for Economic Co-operation and Development) member countries the European Commission whose disbursement records are reported through the Credit Reporting System (CRS) each year, development banks, UN agencies, the Global Fund, non-governmental organizations (NGO's) and private philanthropies including the Bill and Melinda Gates Foundation (Gates Foundation).¹

For the non-Gavi group, we included channels that reported DAH specific for vaccines or immunization program activities. These comprised WHO, NGO's, PAHO, UNICEF, Gates Foundation, US foundations, World Bank International Development Association (WB-IDA), bilateral agencies, and development banks including the Asian Development Bank (ADB) and the Inter-American Development Bank (IDB). DAH from bilateral agencies excluded funds from other donor agencies transferred to any of these channels in order to avoid double-counting. Methods detailing this process have been detailed and published previously [8,9]. In addition, we describe original sources, funding channels and recipient regions illustrating DAH flows to channels and across different channels.

Total funding envelopes for immunization were estimated from channel specific data ranging from 1990 to 2016, while funding classifications into vaccine versus health systems strengthening support as defined for Gavi DAH were assigned using available project-level disbursement data from the CRS also spanning 1990 to 2016, the most recent year for which these data were available. These data consisted over 16,000 projects with respective objective descriptions detailing the intended purposes for the funds tagged to corresponding annual disbursements within specified country or regional locations. We assessed and report the completeness of these data by year compared to data obtained directly from specific channels.

To allocate disbursements into vaccine-specific funding or funding for health systems strengthening, we applied a previously peer reviewed keyword search process used to assign projects to different health focus areas [7]. The key words that were used to identify disbursements in the vaccine specific category included: ‘Pentavalent’, ‘Pneumococcal’, ‘Rotavirus’, ‘Injectable polio’, ‘Polio’

¹ The OECD member countries include Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, South Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

'Human papilloma virus', 'HPV', 'Hep B', 'Hepatitis', 'JEV', 'Japanese Encephalitis', 'HiB mono', 'H. influenza type B', 'Yellow fever', 'DPT' 'DTP', 'Tdap', 'Tetanus', 'Meningitis', 'Men-A', 'Measles' and 'Measles-Rubella (MR)'.

We disaggregated funding for vaccines by vaccine type by identifying all projects that were described as supporting specific vaccines and allocated these funds to the named vaccine. Similarly, we used a set of key words capturing health systems support activities informed by objectives outlined in country Gavi HSS proposals including 'training', 'cold chain', 'monitoring and evaluation' 'information systems', 'infrastructure', 'surveillance', 'maintenance', 'delivery', 'health worker', 'capacity', 'immunization system support', 'advocacy', 'civil society', 'demand', 'distribution', 'cascade', 'mentorship', 'data quality', 'equipment', 'mobilization', and 'management', among others. To account for the robustness of the key word search process, multiple projects were selected at random and assigned categories *a priori*, which were then compared to categories following the key word assignment to ensure the different projects were meaningfully categorized.

We demonstrate funding trends over time for total DAH for immunization starting in 1990, disaggregating Gavi from all other channels, by funding category, and vaccine type. Time was stratified starting 1990–1999 representing the era post universal childhood immunization, 2000–2005 representing Gavi phase I, 2005–2010 for Gavi phase II, and 2010–2015 for phase III. We further illustrate the total DAH trends by income level of recipient countries classified by their gross national income per capita.

In order to estimate the annualized change in funding for immunization from Gavi and non-Gavi channels, we used a generalized linear model with time segments as specified, in order to capture the slope for each segment and level changes between consecutive segments relative to the previous cycle's final year, while relaxing the assumption of linearity between DAH and time. Our results remained robust to varying model specifications where the link and family combinations were interchanged as presented in the [Supplementary Materials](#).

Furthermore, we developed projection models to inform the progress and potential realization of the GVAP funding targets based on segmented linear regression analyses between 2011, the commencement of GVAP, and 2016 the last year for which real time data were available. We applied a linear extrapolation model with uncertainty intervals to predict the funding trajectory of the GVAP through 2020. Our unit of analysis was cumulative DAH aggregating disbursements for 2011, 2012, 2013, 2014, 2015 and 2016. Projections were made for total development assistance, disaggregated by channel group.

All DAH were converted to 2017 USD to account for inflation. We used Stata 15.1 for all analyses.

3. Results

Overall, donor funding for immunization totaled \$34.5 billion between 1990 and 2016. Of this, \$12.4 billion was channeled through Gavi starting 2000, while \$22.1 billion was from other DAH channels between 1990 and 2016. In 2016 alone, immunization DAH was estimated at \$3.2 billion, with \$1.4 billion from Gavi and \$1.8 billion from other channels ([Fig. 1](#)).

The largest sources of funding for Gavi include the United Kingdom, Gates Foundation and the United States, contributing \$3.2 billion, \$2.1 billion, and \$1.5 billion respectively. Of the \$5.1 billion of vaccine funding channeled through UNICEF from 1990 to 2016, \$1.5 billion was contributed by private philanthropy, \$614 million was contributed by the United States, and \$386 million by the United Kingdom. WHO, the third largest channel of immunization funding over this period, was largely funded by the United States and United Kingdom, which provided \$687 million and \$393 million, respectively. The largest public sources of funding were the United States, United Kingdom, Norway, and Germany, funding \$4.6 billion, \$4.5 billion, \$1.9 billion, and \$1.3 billion respectively. Other private sources of funding made up a significant \$3.2 billion. While Gavi is the major implementing agency, it provided funding to other implementing channels such as UNICEF and the WHO.

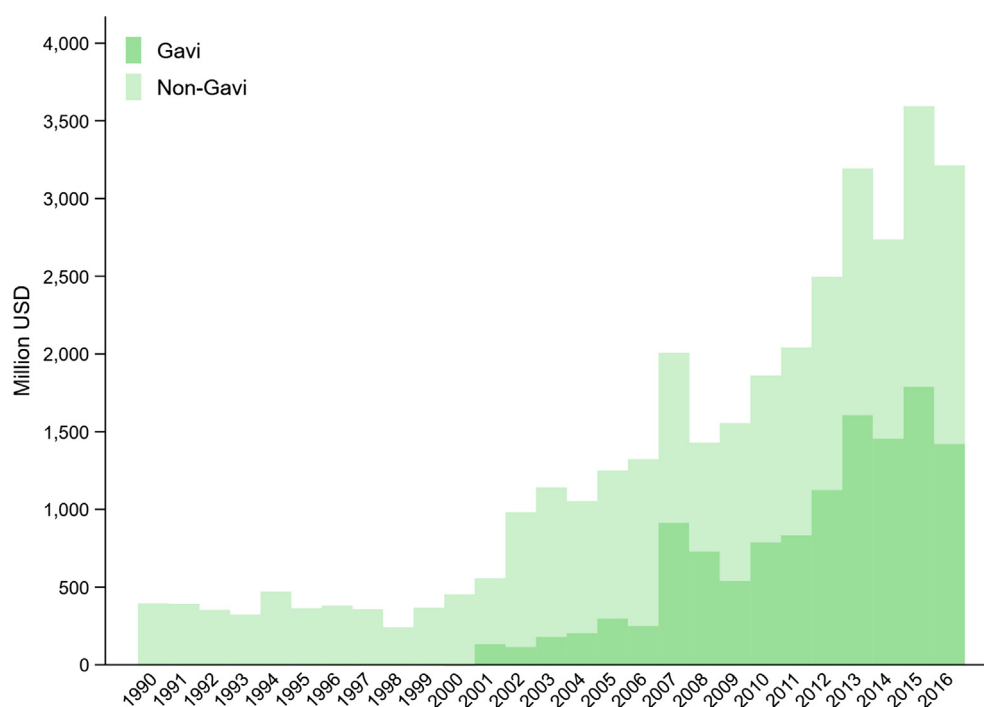


Fig. 1. Total development assistance for immunization, by funding channel, 1990–2016. Values are real currency expressed in 2017 USD. Non-Gavi channels include: WHO, NGO's, PAHO, UNICEF, BMGF, US foundations, World Bank International Development Association (WB-IDA), and development banks including the Asian Development Bank (ADB) and the Inter-American Development Bank (IDB).

From 2000 to 2016, these transfers to UNICEF amounted to \$33.5 million, and transfers to WHO from 2006 to 2016 totaled \$77.0 million.

Between 1990 and 2016 the annual increase in total funding was 10.5% (95%CI: 9.2%-11.9%), with Gavi funding increasing by 23.6% (95% CI: 17.3%-30.3%) after 2000, and other channels increasing by 7.1% (95%CI: 5.9%-8.3%) from 1990 to 2016.

We distinguished immunization DAH by purpose contingent on the availability and extent of granularity of project-level data. For Gavi, about one fifth of total disbursements from 2000 to 2016 were estimated as funds targeting HSS, with allocations increasing over time from 5.1% in 2001, to 18.9% in 2016, peaking in 2008 and 2013 where HSS funds comprised 31.3% and 22.6% of all disbursements respectively (Fig. 2). The annual increase in funding specific for vaccines was comparable to that for HSS estimated at 15.6% (95%CI: 11.7% to 19.6%), and 14.8% (95%CI: 7.9% to 22.2%), respectively.

To characterize funding by specific purpose from non-Gavi channels, we used project-level data from CRS detailing 16,113 projects reported predominantly from bilateral agencies, comprising 67.8% of all immunization-related projects. Other channels reporting through the CRS platform included NGOs (which made up 24.9% of available projects), UNICEF, WHO and the EC (which made up 3.5%, 2.6% and 1% of projects, respectively). In terms of DAH reported, these data represent about one quarter of the total DAH from non-GAVI channels, with reporting levels varying from year to year ranging between approximately 5% (1993) to close to 40% (2008).

Vaccine DAH alone made up 32.4% (\$1.3 billion), funding for HSS comprised 40.9% (\$2.0 billion), while that for other immunization and vaccine-related activities comprised 26.7% (\$1.3 billion), which included projects supporting operational research pertaining to immunization programs, vaccine clinical trials, and vaccine manufacturing or development (Fig. 2). Between 1990 and 2016, funding for vaccines grew by 22.5% (95%CI: 14.2%-31.5%), funding for HSS by 11.7% (95%CI: 8.1%-13.5%), and funding for other activities by 7.7% (95%CI: 3.2%- 12.4%). Furthermore, the trend for funding for vaccines specifically was noted to vary substantially before and after the formation of Gavi, decreasing from 33.8% (95%CI: 8.6% to 65.1%) to 4.8% (95%CI: -1.6% to 11.8%) after 2000. However, funding trends for HSS and other activities during the two time periods were not found to vary significantly.

Complementary to Gavi, UN agencies have by far been the most dominant channels through which immunization programs are

funded, with UNICEF and WHO accounting for 23.1% (\$5.1 billion) and 20.4% (\$4.5 billion) of non-Gavi DAH, respectively. Bilateral agencies provided a comparable amount of funding at 19.9% (\$4.4 billion), while the Gates Foundation has since disbursed 18.0% (\$3.9 billion) starting in 1999. In addition, NGOs disbursed

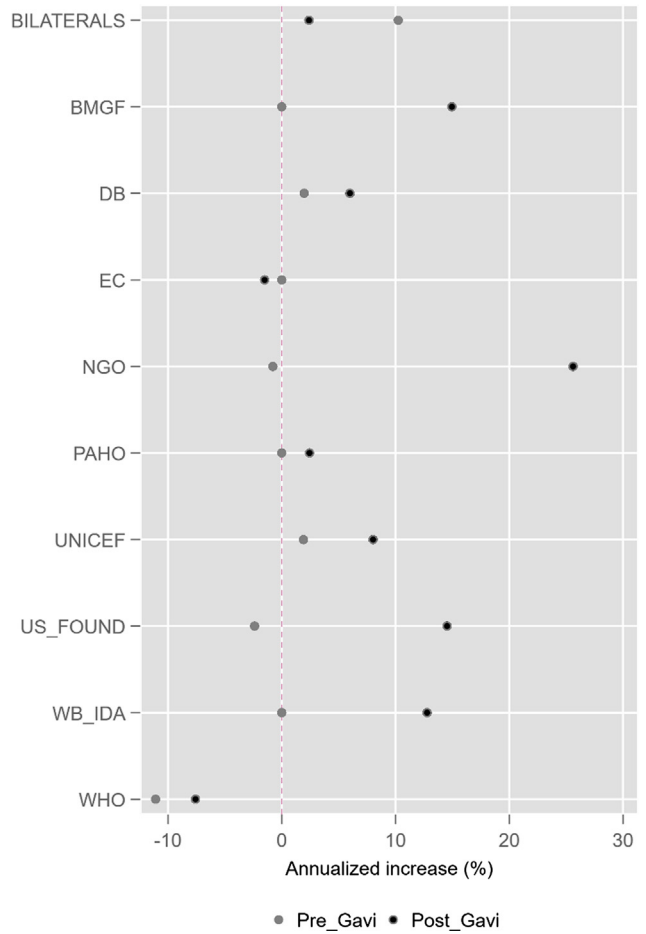


Fig. 3. Annualized change in development assistance for vaccination among Non-Gavi channels.

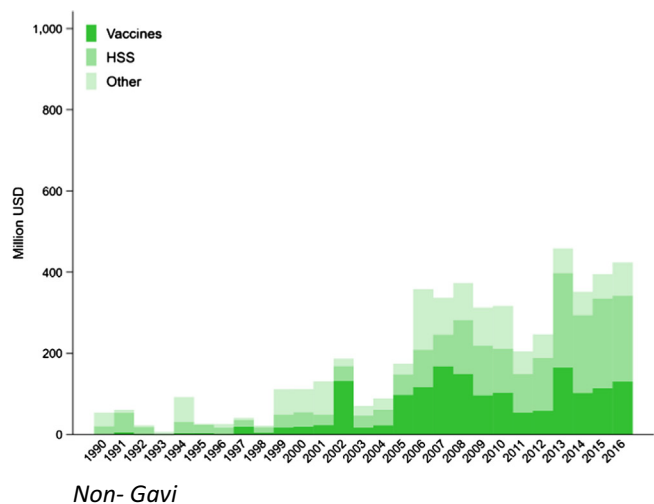
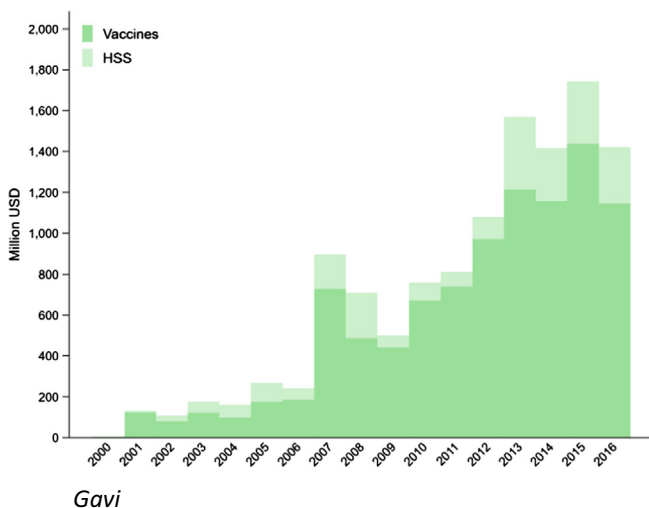


Fig. 2. Development assistance for immunization by purpose, 1990 to 2016.

Table 1
Non-Gavi channel trajectories before and after the creation of Gavi.

Channel	Pre_Gavi (1990–2000)	Post Gavi (2001–2016)
WHO		
Absolute	–24.2 (–36.3 to –12.0)	–18.5 (–24.8 to –12.2)
Relative	–11.1 (–20.3 to –2.0)	–7.6 (–10.2 to –4.9)
UNICEF		
Absolute	5.9 (1.1 to 33.5)	16.6 (12.0 to 21.2)
Relative	1.9 (0.1 to 3.8)	8.0 (6.4 to 9.6)
BMGF	–	
Absolute		22.5 (17.5 – 27.4)
Relative		12.1 (6.5 to 18.0)
PAHO	–	
Absolute		0.5 (0.2 to 0.9)
Relative		2.4 (0.9 to 4.0)
Bilateral agencies		
Absolute	7.4 (0.2 to 14.5)	4.6 (–1.2 to 10.5)
Relative	10.2 (0.9 to 20.5)	2.4 (–0.8 to 5.7)
European Commission	–	
Absolute		–0.3 (–9 to 0.3)
Relative		–3.3 (–10.4 to 4.3)
NGO's		
Absolute	–0.2 (–0.4 to 1.1)	17.1 (13.5 to 20.7)
Relative	–0.8 (–2.1 to 0.5)	25.6 (16.1 to 35.8)
Development banks		
Absolute	0.0 (0.0 to 0.0)	0.9 (0.3 to 1.5)
Relative	1.9 (0.1 to 3.9)	6.0 (–10.3 to 25.2)
World Bank-IDA	–	
Absolute		7.4 (5.1 to 9.7)
Relative		11.6 (4.3 to 19.5)
US Foundations		
Absolute	–0.0 (–0.2 to 0.1)	0.1 (–0.0 to 0.2)
Relative	–2.4 (–11.4 to 7.6)	14.5 (3.5 to 26.8)

*Absolute amounts in millions of USD.

*Relative (%).

*BMGF, PAHO, European Commission and World Bank-IDA do not have sufficient data points to estimate changes before 2001.

11.8% (\$2.6 billion), the WB 4.9% (\$1.1 billion), while PAHO, the EC, development banks and US foundations disbursements each accounted for less than 1% of vaccine DAH channeled outside Gavi.

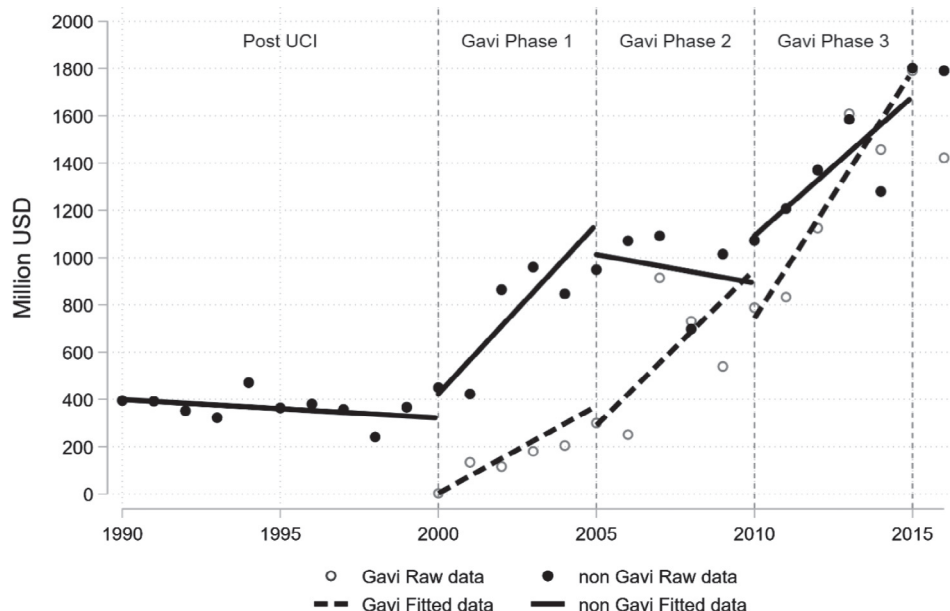
Following the formation of Gavi, funding trends for other channels have varied over time. Between 2000 and 2016, annual dis-

bursements increased for most, with the highest increases in absolute terms coming from NGO's (25.7%), Gates Foundation (14.9%), US foundations (14.5%), World Bank (12.8%), UNICEF (8.0%), and development banks (5.9%). Whereas, funding from bilateral agencies sustained a positive trend, (Fig. 3) the growth in annual disbursements slowed down by 7.8% since the formation of Gavi. Furthermore, funding channeled through WHO continued to decrease, albeit at a slower rate at 7.6% compared to 11.1% before 2000. Table 1 shows the changes in both absolute and relative terms for all non Gavi channels providing immunization DAH.

DAH was further disaggregated by vaccine for Gavi, with pentavalent and pneumococcal vaccines being the highest funded vaccines totaling 40.2% (\$3.9 billion) and 39.0% (\$3.8 billion), respectively. Rotavirus vaccine accounted for 5.9% (\$576 million), meningitis A 2.3% (\$283 million), Hepatitis B mono 1.9% (\$187 million), Injectable Polio 1.9% (\$188 million), measles-rubella 2.9% (\$283 million), Tetravalent DPT-HepB 1.8% (\$178 million) and yellow fever 2.1% (\$203 million). Human Papilloma Vaccine, Haemophilus Influenza B mono, Japanese Encephalitis, and Tetravalent DPT-HiB vaccines each accounted for less than 1%.

A similar approach was taken for non-Gavi project-level data. The majority of non-Gavi DAH targeted towards specific vaccines was highest for polio and measles vaccines, amounting to 64.8% (\$1.74 billion) and 29.1% (\$780 million), respectively. Pentavalent vaccine support made up about 2% (\$53 million), while all the other vaccines each comprised of less than 1% funding tagged towards specific vaccines.

Despite the observed general growth in funding, the trends within different time periods as defined varied considerably for both development channel categories (Fig. 4). Prior to the introduction of Gavi in 2000, DAH for immunization was noted to decline by an estimated –2.1% (95%CI: –4.2% to 0.1%) annually through 1999. During Gavi phase I, funding grew substantially by 53.9% (95%CI: –2.8 to 110.7%), and remained a priority for other agencies with funding increasing by 21.0% (95%CI: 12.6% to 29.4%) annually. Relative to the previous funding cycle, Gavi disbursements maintained an upward trend increasing at 22.9% (95%CI: 2.1% to 43.6%), while non Gavi disbursements receded changing by an estimated –2.5% (95%CI: –7.7% to 2.7%) during phase II. In the recently



*Post UCI (post universal childhood immunization)

Fig. 4. Annualized changes in absolute amounts of development assistance for immunization for Gavi and Non-Gavi channels from 1990 to 2016.

completed phase ending 2015, funding for both Gavi and non-Gavi channels sustained an upward trend growing annually at 17.6% (95%CI: 14.6% to 20.4%) and 8.5% (95%CI: 6.0% to 11.0%) respectively. We made similar assessments by economic status of recipient countries for which substantial DAH was disbursed to low income and lower middle income countries (Fig. 5). Non Gavi DAH decreased or remained flat across the different categories prior to 2000, increasing marginally among both low income and lower- middle income countries. Gavi DAH grew steadily among low income and lower middle income countries compared to upper middle income countries which received less DAH overall, with reductions starting in phase II and plateauing during phase III as shown. Changes in total DAH disbursed by the two channel groups in both relative and absolute terms using different model specifications are presented in supplementary Sections 1 and 2.

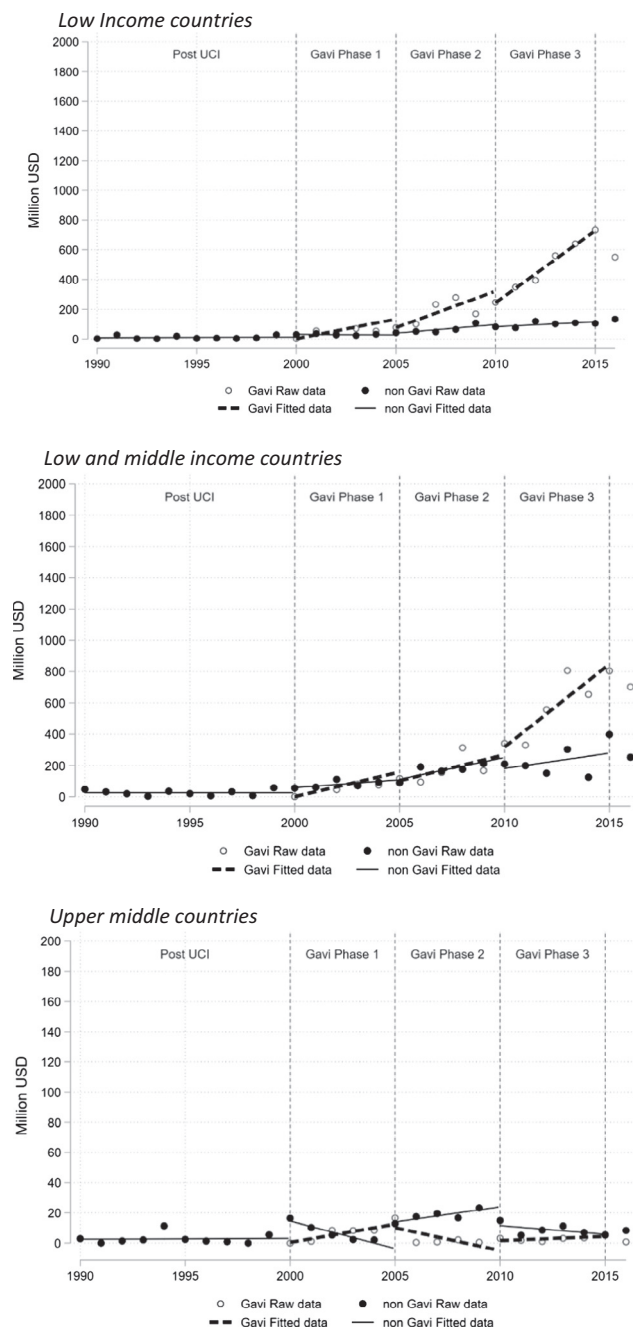


Fig. 5. Annualized changes in absolute amounts of development assistance for immunization for Gavi and Non-Gavi channels from 1990 to 2016 by income level.

Fig. 6 illustrates the total development assistance for immunization by year for the duration of the GVAP period, suggesting that projected target totaling \$12 billion for Gavi has since been achieved, while non-Gavi support is estimated to remain approximately 40% less than the intended target of \$28 billion by 2020. Cumulative amounts by year for the subsequent years through 2020 are presented in Table 2 with a corresponding figure in supplementary Section 3.

4. Discussion

We demonstrate that while donor support for immunization has been substantial, funding trends have shifted over time, and priorities redefined in the recent past. Our analysis provides a detailed description of development assistance for immunization using project-level data from which funds are disaggregated by purpose. We present the trends in funding differentiating investments for vaccine products from immunization program strengthening, which provides insight into the value of implementing and sustaining an existing infrastructure base through which vaccines are delivered. It also allows for additional evaluations on the impact of specific funding categories on vaccination outcomes, although this is beyond the scope of this analysis. We also illustrate the need for continued assessments given current advances in different program outcomes and changes in previous market conditions as we approach the end of what is considered the decade of vaccines.

The commitment from Gavi to increase access to vaccines in low and middle-income countries is evident through the notable focus on vaccine introductions targeting highly prevalent vaccine preventable diseases (VPDs), as much as that on immunization program system strengthening [10].

There is indeed continued support for vaccine products from both Gavi and non-Gavi channels, although the annualized rate for vaccine specific disbursements from the latter was noted to substantially decline after 2000 likely related to a shift in channeling mechanisms through Gavi. This funding trend followed a different course in the recently completed phase, with a surge in 2013 through 2016 driven by an increase in vaccine specific spending echoing the 2013–2018 Polio Eradication & Endgame Strategic Plan (PEESP) [11] endorsed by the 66th World Health Assembly. The PEESP consists of four principal objectives that address polio eradication including withdrawal of trivalent to a bivalent [12] vaccine by 2020 as part of the Global Polio Eradication Initiative. These findings illustrate the shift in mandate and redefined focus among development partners for immunization.

Our data demonstrate that over 90% of vaccine funding from non-Gavi sources targeted polio and measles vaccines, with polio dominating at about 65%, and measles accounting for over 25% of all vaccine-specific funding. This supports the mission of the global eradication strategy that purposes to transition polio resources [13] to measles and rubella (MR) elimination following the 99% success rate] in eradicating all three types of wild polio viruses. The last 1% of polio cases has posed challenges in the elimination agenda mostly due to conflict, political instability, hard-to-reach populations and poor infrastructure [14,15]. As such, a substantial amount of polio resources support surveillance, and using a diagonal approach [13], focusing on measles control would boost case detection for polio among other VPDs hence accelerating progress towards elimination, coverage and equity. It is important to note however, that polio control strategies to achieve the PEESP objectives vary across implementing countries [16–18] to suit their contextual challenges.

With support from non-Gavi channels largely focusing on disease elimination and eradication efforts, our analyses suggest com-

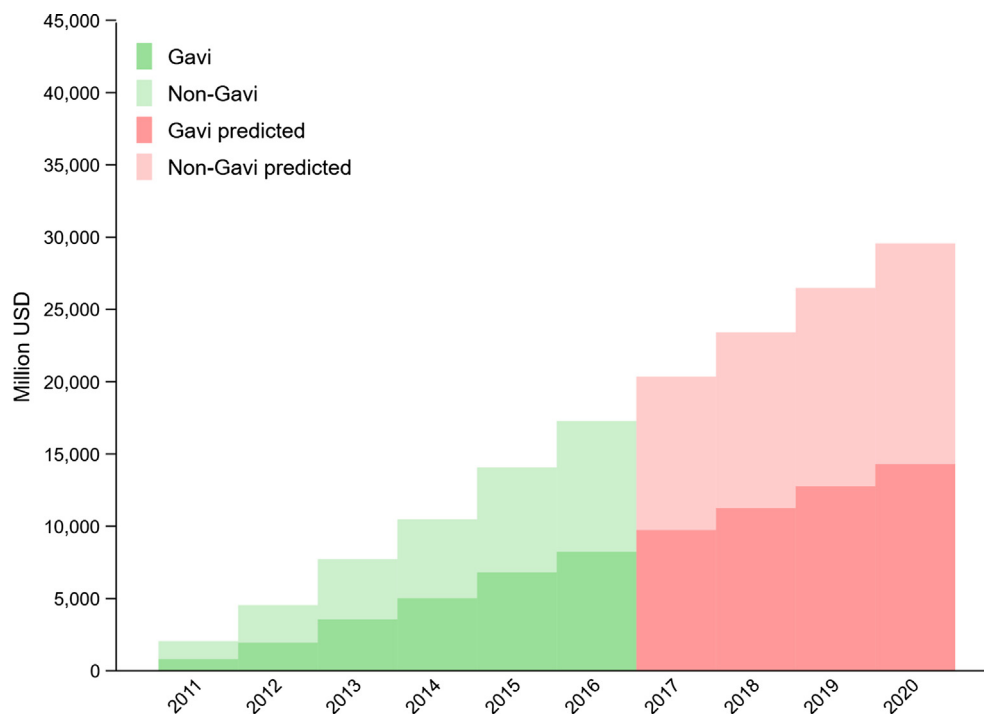


Fig. 6. Estimated projections for the Global Vaccine Action Plan funding targets. Values are real currency expressed in 2017 USD. Non-Gavi channels include: WHO, NGO's, PAHO, UNICEF, BMGF, US foundations, World Bank International Development Association (WB-IDA), and development banks including the Asian Development Bank (ADB) and the Inter-American Development Bank (IDB).

Table 2

Cumulative DAH amounts projected through 2020.

Year	Gavi DAH (95%CI)	Other channels DAH (95%CI)
2017	9.7 (9.0 to 10.4)	10.4 (9.7 to 11.1)
2018	11.2 (10.5 to 11.9)	11.9 (11.1 to 12.7)
2019	12.7 (11.8 to 13.6)	13.5 (12.6 to 14.4)
2020	14.2 (13.3 to 15.2)	15.1 (14.0 to 16.1)

*Amounts in billions of 2017 USD.

*Gavi target by 2020: 12 billion.

*Target for all other channels: 28 billion.

*Projections based on disbursements following GVAP implementation in 2011.

plementarity given Gavi's focus on scaling up new and under-used vaccinations against highly prevalent VPDs. Pentavalent previously administered as tetravalent, pneumococcal, and rotavirus vaccines have made up over 80% of vaccine introduction grants from Gavi, targeting childhood pneumonia and diarrhea, which together with malaria account for one third of childhood deaths globally and 40% of deaths in sub-Saharan Africa [19,20]. The sustained prioritization of vaccines overall with a scale up approach from Gavi and a complementary mop up approach from non-Gavi channels offers promise towards improving new vaccine coverage while continuing to reach marginalized populations.

In terms of program system strengthening, Gavi supported specific activities addressing system constraints through its ISS programs prior to the introduction of country driven [21] health systems cash support processes formally in 2005, which overall has been estimated to grow at 15% annually, analogous to vaccine funding. The decline in Gavi DAH disbursed to upper and middle income countries starting in phase II aligns with the funding objective to strengthen broader health services [22] beyond the immunization program for which lower income countries continued to benefit compared to upper income recipient countries.

Nonetheless, funding prospects for non-Gavi channels based on observed trends appear to remain unfeasible at this point relative

to initial funding estimates. In order to achieve the GVAP objectives between 2011 and 2020, an estimated \$50 billion to \$60 billion was required [2] contingent on a number of market shaping assumptions and conditionalities from both government and donor perspectives. Donor commitments totaled \$40 billion, of which \$12 billion would be mobilized from Gavi and \$28 billion from other development partners. Funding targets as per our analyses were estimated to be on track for Gavi, which is estimated to reach the stipulated targets by the end of 2018, in contrast to non-Gavi channels for which our projections suggest that funding is likely to remain short by an estimated 40% by the end of the 2020.

This may be attributable to continued stagnation or deceleration among different channels supporting immunization following the creation of Gavi. As indicated, UN agencies, bilateral agencies and the Gates Foundation disbursed the highest amounts of aid overall among the non-Gavi channels; however, we also highlight reductions after 2000 from WHO and bilateral agencies in relative terms. And while there were considerable increases in annual funding from Gates Foundation, support for immunization channeled outside Gavi has predominantly targeted technology and innovation through research and development [23,24]. On the other hand, the downward trend might have resulted from changes in different determinants from which initial funding targets were estimated. For example, vaccine prices [25] have declined over time, and market conditions for some vaccines such as rotavirus and HPV have created shortages which potentially might have led to downward pressure on total expenditures [26].

Based on initial estimates, the observed trajectory poses a threat towards achieving universal immunization coverage and disease elimination targets as described in the current global agenda for immunization. Past trends suggest that fluctuations in funding are influenced by the development agenda [27,28] where partner mandates and funding priorities are redefined to align with changes to the global agenda. Therefore, timely and detailed resource tracking assessments such as ours provide critical evidence to guide discussions or decisions on how to sustain alloca-

tions primarily from governments, with development partners playing a supplementary role where gaps exist. With interim resource tracking assessments, country multi-year plans can be updated to allow for changes in resource mobilization efforts based on real time evidence. Furthermore, available funding at points of implementation can be redirected to underserved regions or populations where the net gain from existing resources would be maximized.

The main limitation for our study is the incomplete nature and potentially unrepresentative project-level data for non-Gavi channels based off the OECD-CRS database. Relatedly, in using the keyword search, DAH is allocated proportionally to purpose category or specific vaccine based on the number of keywords found. Although this process may affect the construct validity of specific funding distributions, the potential impact on allocations is non-disproportionate. Different approaches estimating DAH for maternal and child health have used different time periods and rationales [29,30] against which disaggregation is performed resulting into quantitative disparities in program level DAH. Missing data could have led to underestimation of the funding envelopes for the three categories overall, and masked the true changes in funding priorities for these channels following the formation of Gavi. This echoes the appeal for continued improvements in reporting procedures [24,31] from development partners by instituting complete, timely and standardized project level data allowing for comprehensive, comparable and accurate assessments of financial disbursements. In this analysis, we do not examine the role of domestic funding for immunization or primary health care expenditure, both of which are critical drivers of development assistance. Previous assessments suggest that countries spending on immunization are positively and significantly correlated with their gross national income [32,33], and have covered over 80% of their budgets. However, projections call for significant increases in the investment functions of reporting countries in order to meet 2020 targets. Data on government expenditure on immunization are available through WHO/UNICEF joint reporting form, although concerns remain regarding reliability arising from variation in data quality, timeliness and accuracy [34]. Continued improvements in the data quality for government expenditure by health program area would improve resource tracking practices overall, allow for a bidirectional resource mobilization process where one source is lacking, and test for potential program specific subadditionality. In addition, future analyses should also include primary health care (PHC) expenditure of which immunization is an essential component [35] to assess how PHC resources compare with immunization expenditure.

Global initiatives are increasingly adopting program or disease specific approaches with time sensitive indicators of success. The current global agenda for immunization takes on a multidimensional pursuit towards enlarging the scope of vaccines while reinforcing elimination and eradication efforts. This analysis measures financial resources to evaluate progress towards these efforts highlighting areas of success as seen for Gavi, and where renewed strategies are imperative as for the other channels of immunization DAH. Iterative assessments such as this provide key information to facilitate more focused evaluation, advocacy, and resource allocation approaches towards achieving universal coverage.

Conflict of interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2018.10.062>.

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