

Childhood routine immunization in the Philippines

A literature review on determinants and interventions

Waka Shibata

Japan

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Vrije Universiteit Amsterdam

Childhood routine immunization in the Philippines: A literature review on determinants and interventions

A thesis submitted in partial fulfilment of the requirement for the degree of
Master of Science in International Health

by

Waka Shibata

Declaration:

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A handwritten signature in black ink that reads "Waka Shibata". The signature is written in a cursive, flowing style.

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List of abbreviations

ARMM	Autonomous Region in Muslim Mindanao
BHW	barangay health worker
CENTRAL	Cochrane Central Register of Controlled Trials
CHW	community health worker
COVID-19	coronavirus disease 2019
cVDPV	circulating vaccine-derived poliovirus
DOH	Department of Health
DTP	diphtheria and tetanus toxoids and pertussis-containing vaccine
EPI	Expanded Programme on Immunization
EPOC	Effective Practice and Organisation of Care group
EVM	Effective Vaccine Management
GNI	Gross National Income
GRISP	Global Routine Immunization Strategies and Practices
HPV	human papillomavirus vaccine
INR	Indian Rupee
KES	Kenya Shilling
LGU	local government unit
LMIC	low- and middle-income country
MIC	middle-income country
NIC	National Immunization Committee
NITAG	National Immunization Technical Advisory Group
NFC	near field communication
PBF	performance based financing
PCV	pneumococcal conjugate vaccine
RED	Reaching Every District
REP	Reaching Every Purok
TPB	Theory of Planned Behaviour
UHC	universal health coverage
UNICEF	United Nations International Children's Emergency Fund
USD	United States Dollar
VII	Vaccine Independence Initiative
VPD	vaccine-preventable diseases
WHO	World Health Organisation

Abstract

Introduction: Vaccines are a powerful tool for preventing childhood death and disease. Routine childhood immunization rates in the Philippines are declining. My thesis aims to understand why vaccine uptake is falling and explore how to improve coverage.

Methods: I conducted a literature review on the determinants of routine childhood immunization coverage in the Philippines and a rapid review of the literature on interventions to increase childhood immunization coverage in low- and middle-income countries (LMIC).

Results: Many determinants on both the supply and demand sides interact to influence vaccine coverage in the Philippines. I identified 50 studies from 22 countries on interventions to increase childhood immunization coverage in LMICs. I found evidence that short message service text reminders, call reminders, community-based health education, outreach services, home visits, lay health worker interventions, and incentives combined with other interventions can improve coverage.

Discussion: The current most important inhibitors to increased coverage in the Philippines are to do with vaccine supply and access to vaccination services. A combination of strategies to secure the foundations of the routine immunization system and interventions to accelerate routine immunization activities will be required to improve coverage. Stronger national leadership and governance and increased support for local government units in managing immunization programs are necessary. Involving the community in implementing evidence-based, targeted interventions to address identified barriers to vaccination will improve coverage.

Keywords: Philippines, childhood immunization, determinants, immunization coverage, interventions

Word count: 12,124 words

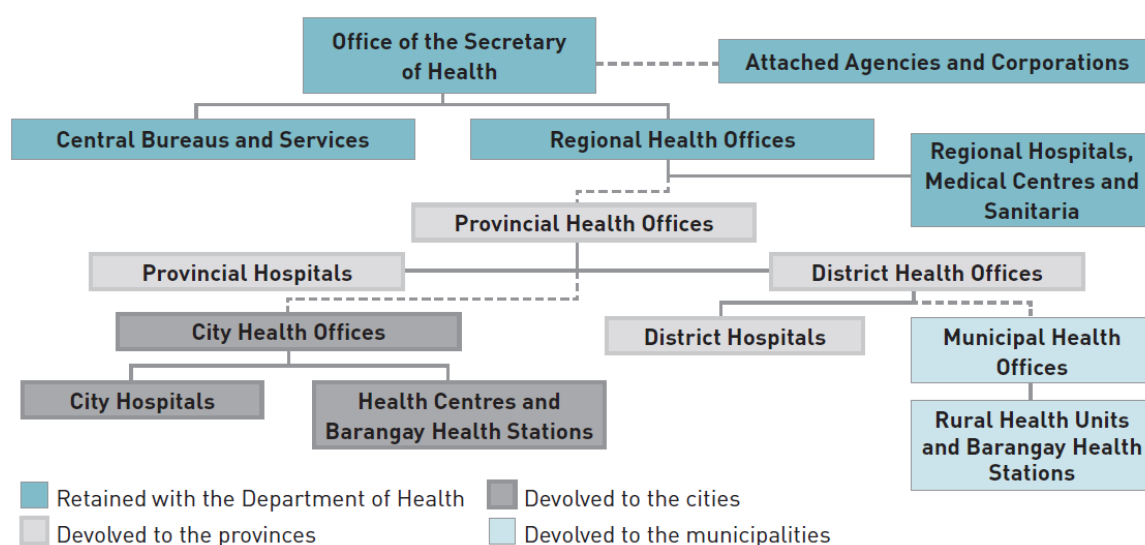
1 Background

The Philippines is an archipelagic nation in the West Pacific with a population of 108 million (1). The country was a Spanish colony from the 16th century, ceded to the United States of America in 1898, and became independent in 1946 (2). Due to these historical circumstances, almost 80% of the population are Roman Catholic, and English is one of the official languages (3). The majority of the population is of Malay ancestry, but contemporary Filipinos consist of nearly 100 distinct ethnic groups (3). The Philippines is classified as lower-middle-income by the World Bank according to its Gross National Income (GNI) per capita (4) and is one of the fastest-growing economies in Asia (5). The adult literacy rate is over 95% for both men and women (6).

The life expectancy at birth of Filipinos increased from 63 years in 1980 to 71 years in 2019 (1). Over the same period, the nation has been undergoing an epidemiological transition. The current situation has been dubbed a triple burden: many still suffer from infectious diseases, urbanisation and lifestyle changes have led to an increase in non-communicable diseases, and the additional burden that endangers citizens and can possibly hamper the delivery of health services is the high risk of natural disasters (7). The World Risk Index, which assesses the risk of disasters that arise from extreme natural events, ranked the Philippines as the eighth most vulnerable country in the world in 2021 (8). Of particular concern is typhoons, as climate change appears to be exacerbating their intensity (9).

The Philippines has a highly decentralised health system with the Department of Health (DOH) providing leadership and local government units (LGU: provinces, cities, and municipalities) and private entities responsible for managing and implementing local programs and services (Figure 1.1) (7). A national health insurance mechanism, the Philippine Health Insurance Corporation, was introduced in 1995 and progress is being made towards universal health coverage (UHC). However, out-of-pocket payments still make up over 50 percent of total health expenditure (10).

Figure 1.1 Organisational structure of the Philippine health care system (7)



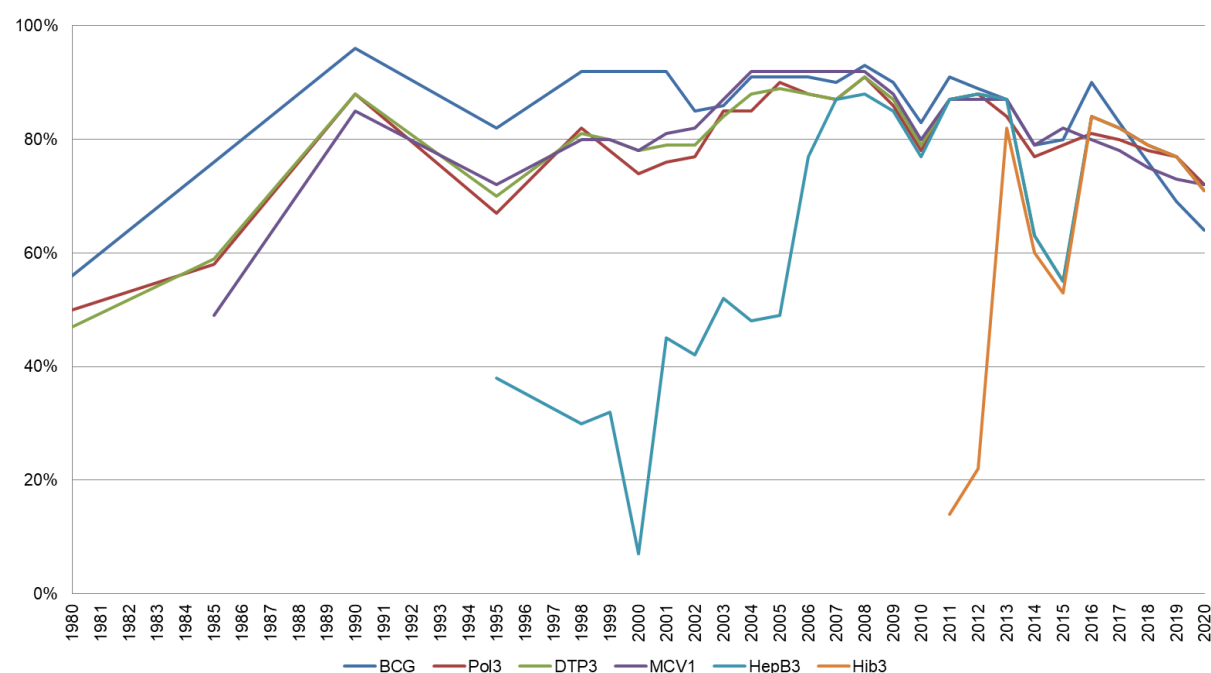
2 Problem statement and objectives

2.1 Problem Statement

Vaccines are among the most successful public health interventions in combating childhood disease and death (11). Furthermore, they have societal benefits such as promoting economic growth, enhanced equity, and women’s empowerment (11). In low- and middle-income countries (LMIC), routine immunization programs are the cornerstone of primary health care services and provide a platform for broader health services (11).

The Expanded Programme on Immunization (EPI) was established in the Philippines in 1976, making immunization against the six diseases of tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis, and measles compulsory for children below eight years of age (12). The EPI initially got off to a promising start and in the 1980s immunization rates rose and the incidence of vaccine-preventable diseases (VPD) began to decline (Figures 2.1, 2.2) (13,14). The last case of wild polio was recorded in 1993, and polio was declared eradicated in 2000 (15).

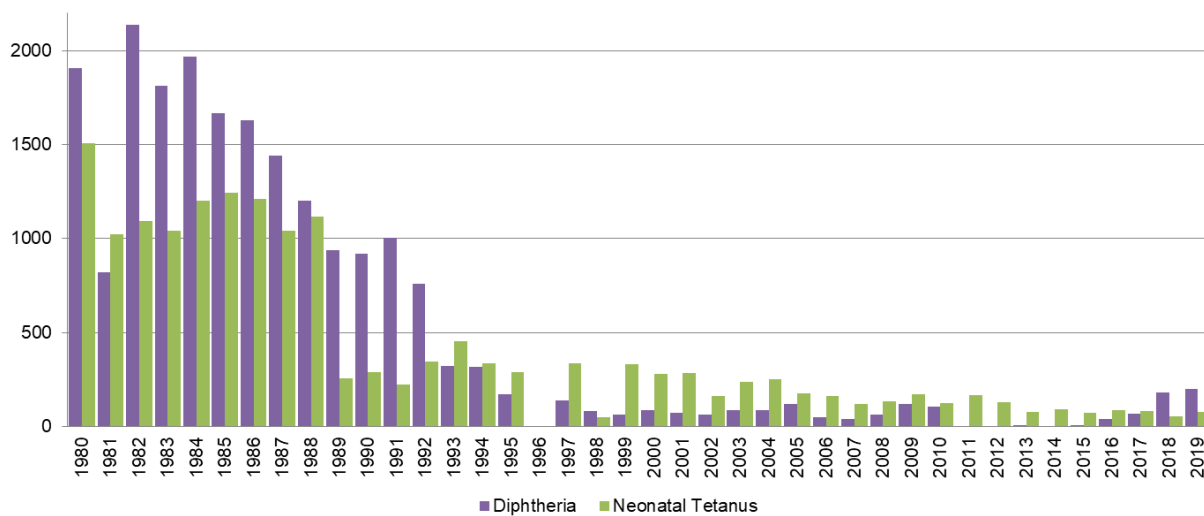
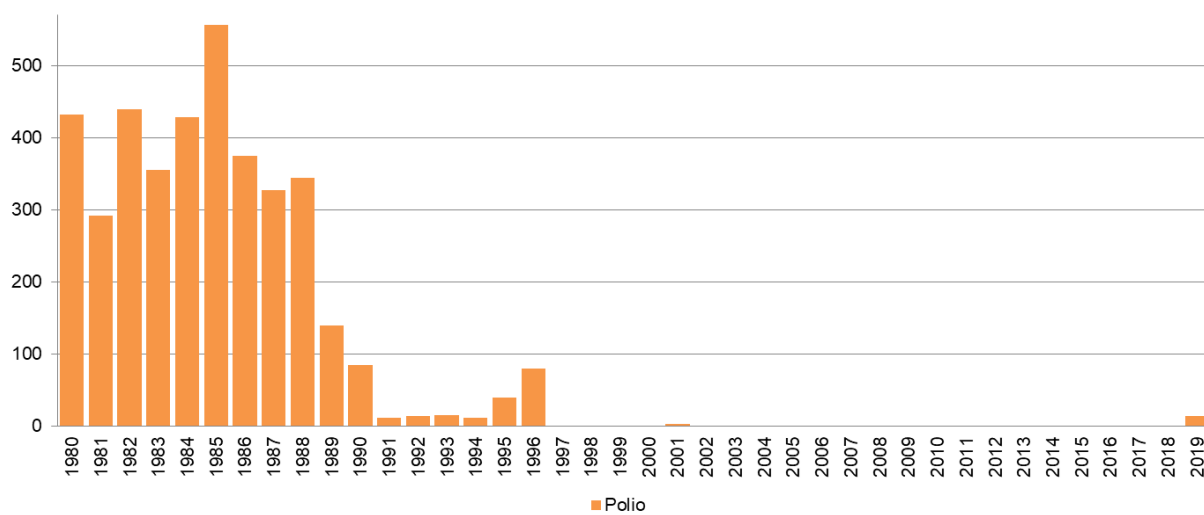
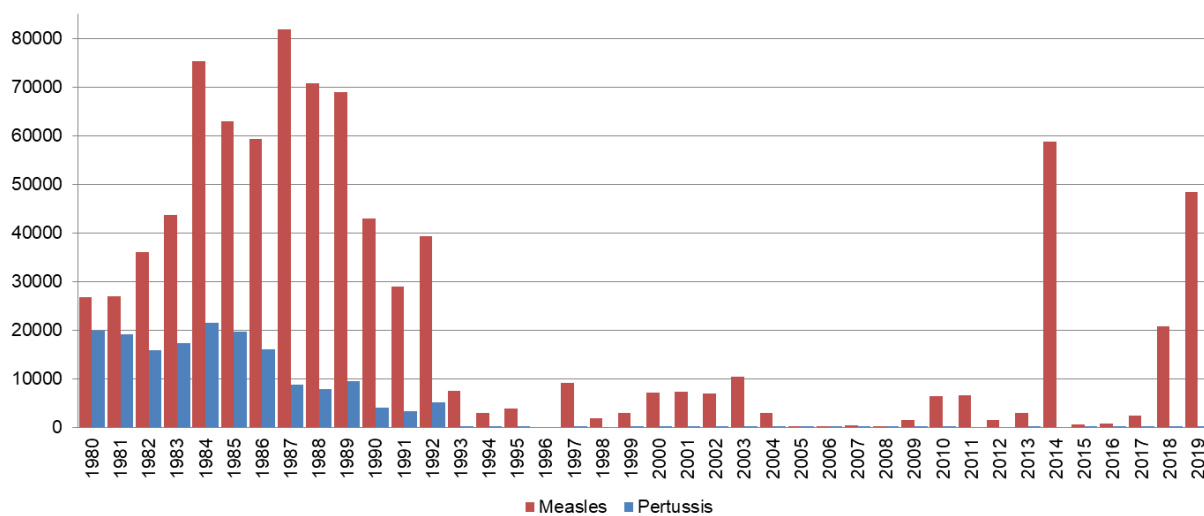
Figure 2.1 WHO/UNICEF immunization coverage estimates for the Philippines 1980-2020 (13,14)



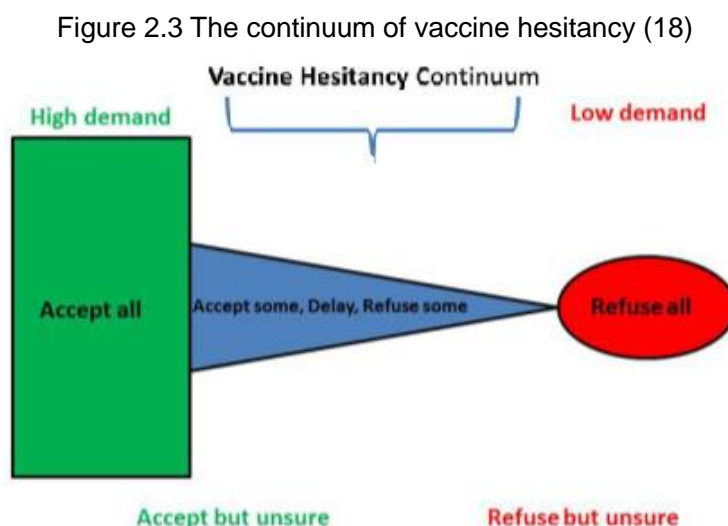
1980-2008 data from (13), 2009-2020 data from (14), WHO: World Health Organisation, UNICEF: United Nations International Children’s Emergency Fund, BCG: Baccille Calmette Guérin vaccine, Pol3: third dose of polio vaccine, DTP3: third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine, MCV1: first dose of measles-containing vaccine, HepB3: third dose of hepatitis B vaccine, Hib3: third dose of *H. influenzae* type B vaccine

In the 1990s and 2000s, immunization rates stagnated at below 90% (13). In 2010, the EPI was revised and expanded to cover mumps, rubella, Hepatitis B, and *H. influenzae* type B (16). Vaccines were provided for free at government health facilities for children up to five years of age (16). Nevertheless, immunization rates have continued a general decline in the past decade (14). There have been measles outbreaks (13) and circulating vaccine-derived poliovirus (cVDPV) – a variant that can arise when vaccination coverage is low – was detected in 2019 (15).

Figure 2.2 Number of reported cases of vaccine-preventable diseases in the Philippines 1980-2019 (13)



The rise of vaccine hesitancy threatens to undermine the success of immunization in combating VPDs, and in 2019 the World Health Organisation (WHO) identified it as one of the top ten threats to global health (17). According to the Strategic Advisory Group of Experts Working Group, vaccine hesitancy refers to “delay in acceptance or refusal of vaccines despite their availability” (18). It is set on a continuum between the two extremes of full acceptance and outright refusal (Figure 2.3) (18).



A few years ago, the Philippines experienced an infamous controversy that eroded vaccine confidence (19). In March 2016, a school-based dengue virus vaccination program was launched with a newly approved vaccine, targeting nine-year-old children in the three regions with the highest incidence (20). In November 2017, the manufacturer Sanofi Pasteur released an advisory warning that its vaccine could cause severe disease in those who had never been exposed to the virus. There was a dramatic and politicised response fuelled by media hype (21). The fear triggered by this panic is reported to have disrupted routine vaccine uptake and led to the measles outbreaks of 2018 and 2019 (22,23).

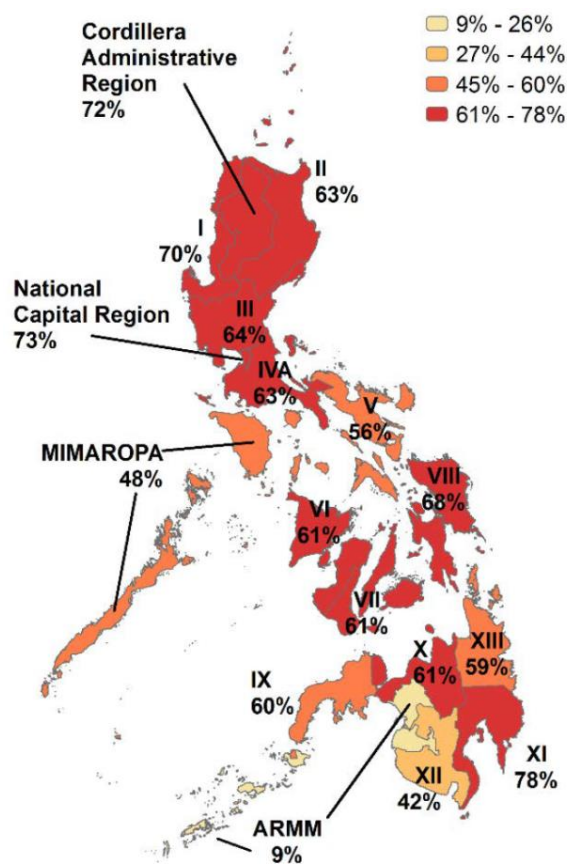
Household surveys are generally considered the most reliable sources of immunization coverage in LMICs (24), and the most recent large-scale national survey in the Philippines was the Demographic and Health Survey (DHS) in 2017 (25,26). Some key findings were that vaccination increases with household wealth and mother’s level of education and is higher in urban areas (Table 2.1) (25). Whereas 74% of children aged 12-23 months in the highest wealth quintile had received all age-appropriate vaccines, in the lowest quintile the figure was only 47% (25). The figures for children whose mothers had college education was 74%, whereas if mothers had primary school education it was only 39% (25). Likewise, it was 67% in urban areas versus 57% in rural areas (25). Results also revealed wide disparities by region (Figure 2.4) (25). Coverage is lowest in the Autonomous Region in Muslim Mindanao (ARMM), where only 9% of children aged 12-23 months are fully vaccinated (25).

Table 2.1 Percentage of children aged 12-23 months who received all age-appropriate vaccinations and no vaccinations by characteristic, DHS 2017 (25)

Background characteristic	All age-appropriate vaccines	Number of children surveyed
Mother's education		
No education	(15.2)*	19
Grades 1-6	38.5	302
Grades 7-10	61.7	1,043
Post-secondary	72.6	85
College	74.2	484
Wealth quintile		
Lowest	46.7	529
Second	60.0	410
Middle	66.0	412
Fourth	70.6	328
Highest	73.6	254
Residence		
Urban	66.9	885
Rural	56.5	1,048

DHS: Demographic and Health Survey, * based on a small number of unweighted cases

Figure 2.4 Percentage of children aged 12-23 months who received all age-appropriate vaccinations by region, DHS 2017 (25)



DHS: Demographic and Health Survey, ARMM: Autonomous Region in Muslim Mindanao

Immunization rates are far from national targets of 95% (27) and remain low compared to other WHO West Pacific Region and Association of Southeast Asian Nations middle-income countries (MIC) with similar populations (Table 2.2) (28). The Philippines also ranks among the top ten countries worldwide with the most zero-dose children – surviving infants who did not receive the first dose of diphtheria and tetanus toxoids and pertussis-containing vaccine (DTP) (29). Gavi, the Vaccine Alliance, is a public-private partnership created in 2000 to increase access to vaccines in poor countries (30). Eligibility for Gavi support is determined by average GNI per capita over the last three years (31). The Philippines is a MIC that is not eligible for Gavi support, and it is widely acknowledged that these countries are struggling to maintain high coverage and introduce new vaccines (32,33).

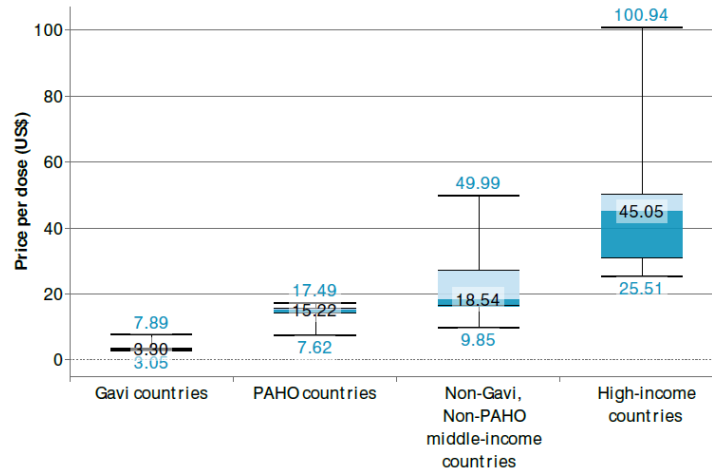
Table 2.2 WHO/UNICEF estimates of national immunization coverage for DTP3 in MICs in the WPR and ASEAN with populations in the millions, 2016-2020 (28)

Country	Income*	Gavi support**	2020	2019	2018	2017	2016
Cambodia	lower-MIC	eligible	92	92	92	93	93
Indonesia	lower-MIC	eligible	77	85	85	85	84
Lao PDR	lower-MIC	eligible	79	80	85	84	83
Malaysia	upper-MIC	non-eligible	98	98	99	99	95
Mongolia	lower-MIC	eligible	96	98	99	99	99
Myanmar	lower-MIC	eligible	84	90	91	89	90
Papua New Guinea	lower-MIC	eligible	39	35	35	36	46
Philippines	lower-MIC	non-eligible	71	77	79	82	84
Thailand	upper-MIC	non-eligible	N/A	97	97	99	99
Viet Nam	lower-MIC	eligible	94	89	75	94	96

WHO: World Health Organisation, UNICEF: United Nations International Children's Emergency Fund, DTP3: third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine, MIC: middle-income country, WPR: Western Pacific Region, ASEAN: Association of Southeast Asian Nations, Lao DPR: Lao People's Democratic Republic
 *classification by World Bank according to Gross National Income per capita (4) **as of 2017 (33)

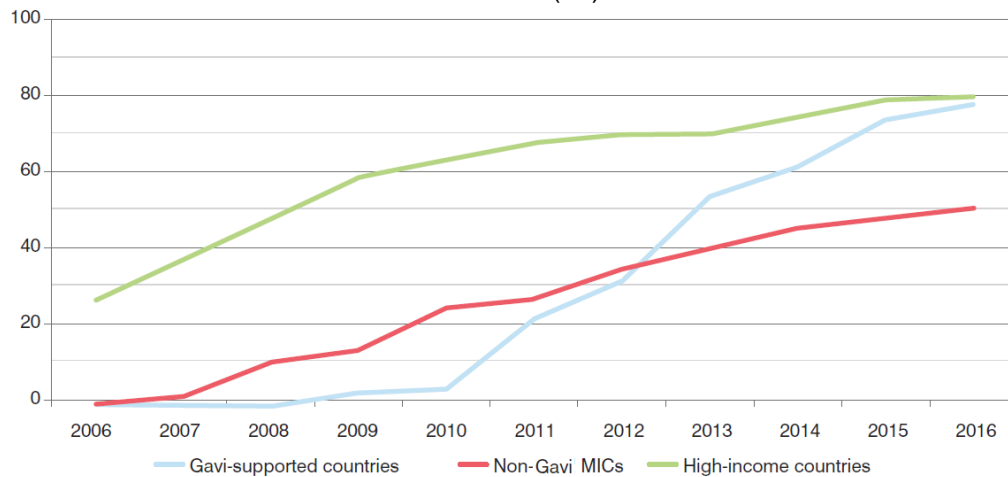
Affordability is a significant problem for non-Gavi MICs when introducing new vaccines. The number of diseases against which the WHO recommends vaccination has doubled between 2001 and 2014, and during the same period, the cost of immunizing a child against all these diseases has multiplied at least 68-fold (34). Additionally, although a lack of transparency in the vaccine market continues to obscure the picture, there appears to be an association between GNI per capita and vaccine price. For example, prices for pneumococcal conjugate vaccine (PCV) by country category can be seen in Figure 2.5 (33). Consequently, non-Gavi MICs are lagging behind both high-income and Gavi-supported countries in introducing PCV (Figure 2.6) (33). The Philippines has not successfully introduced PCV, human papillomavirus vaccine (HPV), or rotavirus vaccine (33).

Figure 2.5 Price by country category for pneumococcal conjugate vaccine, 2016 (33)



Pan American Health Organisation (PAHO) countries use pooled procurement strategies to negotiate prices (35)

Figure 2.6 Percentage of countries with pneumococcal conjugate vaccine in the immunization schedule (33)



A broad range of issues affects vaccine coverage. Thus, interventions to address determinants and raise coverage are equally varied. They can be targeted at recipients, providers, or the health system; they can be single or multi-faceted interventions. A table of the types of interventions and how they work is available in Appendix 1 (36,37). The WHO Global Routine Immunization Strategies and Practices (GRISP) framework recommends distinguishing between two perspectives when understanding routine immunization (Appendix 2) (38). As a fundamental part of the health system, immunization service delivery can be seen as a challenge requiring a systems approach and multi-disciplinary attention (38). The other dimension is approaching it as the process to regularly deliver vaccines according to schedule and specific activities designed to boost coverage (38). The GRISP framework points out that strategies to strengthen routine immunization systems, in the sense of the first perspective, may not result in short-term improvements in coverage (38).

2.2 Objectives

The objectives of my thesis are to, in the context of the routine immunization system for children in the Philippines:

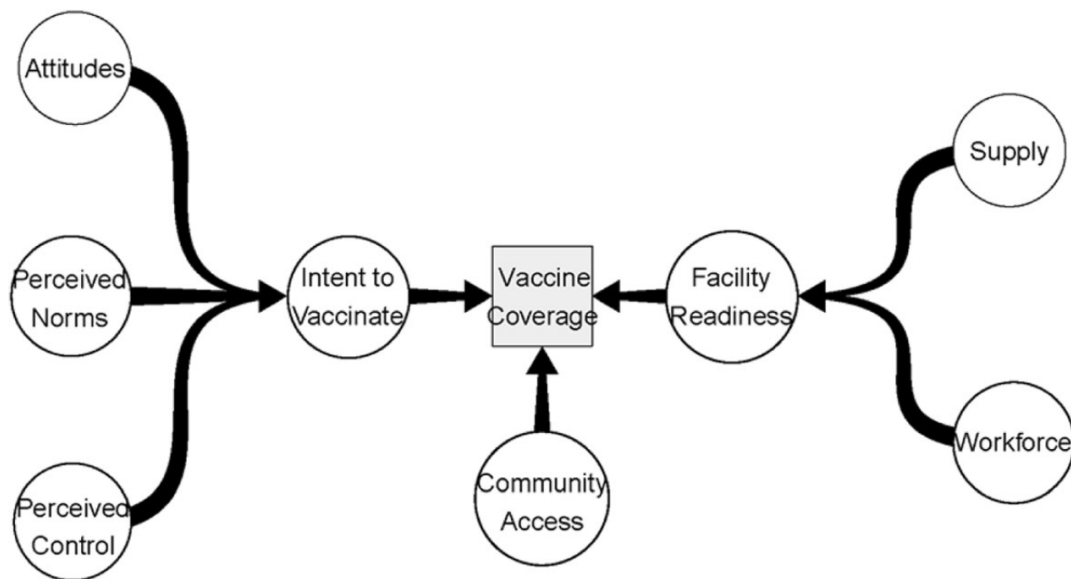
1. Understand why coverage is not improving.
 - 1.a. Analyse the determinants of coverage.
 - 1.b. Determine the current most important inhibitors of coverage.
2. Explore how to improve coverage.
 - 2.a. Review the literature on interventions to improve coverage in LMICs.
 - 2.b. Suggest how to improve coverage in the Philippines.

3 Methods

Framework

I used the following framework on the determinants of vaccine coverage to guide my research (Figure 3.1). This framework was conceptualised by Phillips et al. through an interpretive synthesis based on a systematic review of childhood vaccination in LMICs (39). They analysed the content of 78 articles and integrated three existing conceptual frameworks on vaccine coverage (40–42) into a comprehensive framework. This framework also draws on established frameworks; the contributing factors to facility readiness, supply and workforce, were identified from the WHO Health System Building Blocks Framework as the most proximal components of a successful health system (43); and the intent to vaccinate component of the framework is based on the Theory of Planned Behaviour (TPB) (44). An essential third construct between supply and demand identified by Phillips et al. is community access – “the ability (or inability) to carry out the transaction of vaccine utilisation, i.e., barriers and facilitators between intent and readiness” (39).

Figure 3.1 Determinants of vaccine coverage (39)



Literature review on determinants of vaccine coverage in the Philippines

For the first objective of understanding why routine child immunization coverage in the Philippines is not improving, I used Google Scholar and PubMed to search for English literature using the keywords detailed in Appendix 3. I also referenced websites of UN agencies and the Philippine government and other grey literature, and used snowballing to find information. I followed my guiding framework to analyse my findings.

Rapid review of literature on interventions to improve vaccine coverage in LMICs

For the second objective of exploring how to improve coverage, I conducted a rapid literature review on interventions to improve routine childhood immunization coverage in LMICs. There are four oft-cited systematic reviews on strategies to increase routine immunization coverage in LMICs (36,45–47). Most are outdated, but the search methods and results provide insights, and I have summarised them in Appendix 4. I based my search method on that of the most recent of these four reviews: a Cochrane Effective Practice and Organisation of Care (EPOC) review by Oyo-Ita et al. on interventions for improving coverage of childhood immunizations in LMICs (36).

I searched Cochrane Central Register of Controlled Trials (CENTRAL) following the search strategy used by Oyo-Ita et al., which I have detailed in Appendix 5. I only searched Cochrane CENTRAL as all the studies in the review by Oyo-Ita et al. were indexed there. Because the review by Oyo-Ita et al. conducted a search in 2016, I included studies from their review and limited my search to studies published after 2016. I searched the Cochrane Database of Systematic Reviews and found four more reviews on overlapping topics (48–51) and included studies from these reviews as well.

I defined six criteria for inclusion of studies:

- (i) Studies involving children under five years of age receiving WHO-recommended vaccines through routine childhood immunization services. Interventions targeted at caregivers, health care providers, the health system, or combinations of these were also included. Supplementary immunization activities and school-based immunization services were excluded.
- (ii) Studies conducted in a LMIC as defined by the World Bank (4).
- (iii) Randomised trials, non-randomised trials, controlled before-after studies or interrupted time series studies based on guidelines developed by the Cochrane EPOC group (52). Contrary to Cochrane EPOC guideline recommendations, I included studies with only one intervention or control site.
- (iv) Published in English.
- (v) Published in a peer-reviewed scientific journal.
- (vi) Outcomes include quantitative estimates of vaccination coverage.

I screened titles and abstracts of studies with the aid of Rayyan (53) for potential eligibility and retrieved the full texts of potentially eligible studies. I then applied the inclusion criteria to identify relevant studies. I used Microsoft Excel to tabulate extracted data such as authors, year of publication, year(s) of study, design, purpose, setting, participants, interventions, outcomes, and results. I did not assess the quality of the studies and my synthesis of the literature is narrative.

4 Results

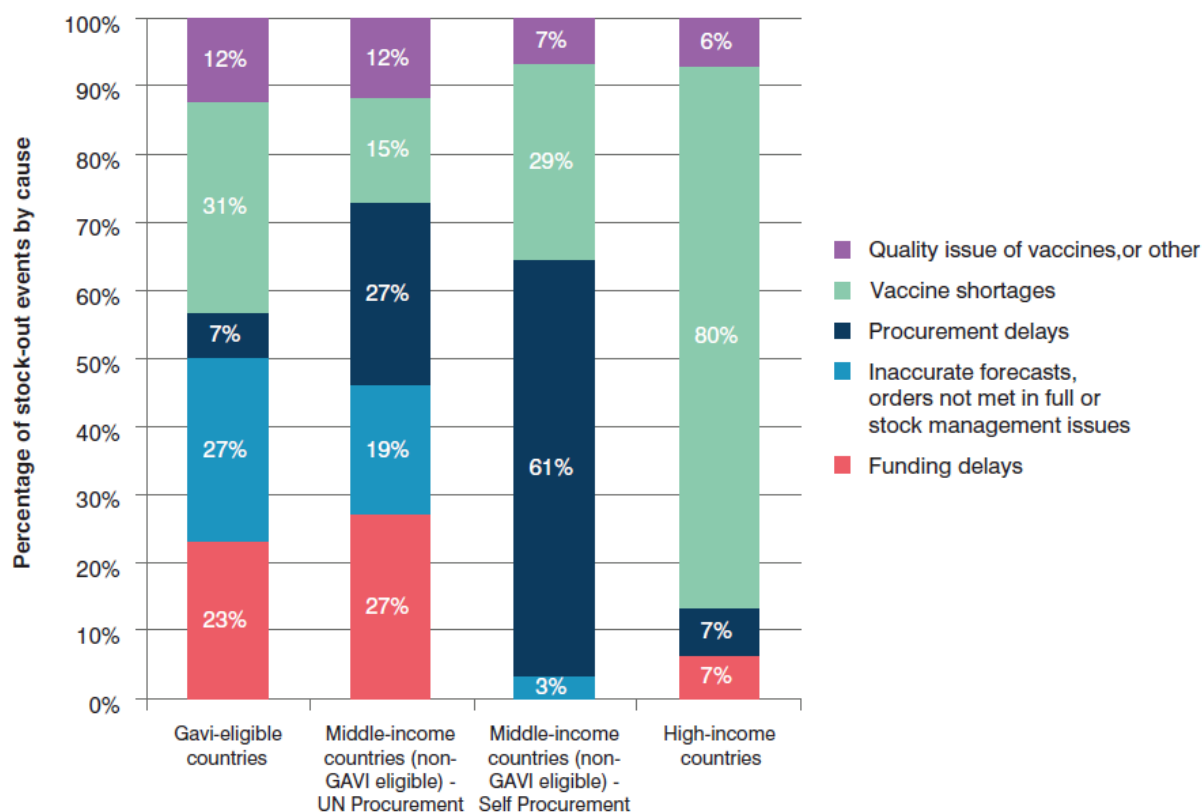
4.1 Determinants of vaccine coverage in the Philippines

Supply

When the EPI started in the Philippines, vaccines were provided for free by United Nations International Children's Emergency Fund (UNICEF); however, the DOH began to take responsibility for procurement as the economy improved in the mid-1990s (7). Vaccines are currently purchased either through negotiation with the Vaccine Independence Initiative (VIII) or directly from manufacturers via a tender process (54). The VII was established in 1991 by WHO and UNICEF to support lower-MICs aiming to become independent in vaccine procurement (55). It enables countries to participate in a pooled procurement mechanism and benefit from the stable, affordable prices made possible by leveraging economies of scale (55).

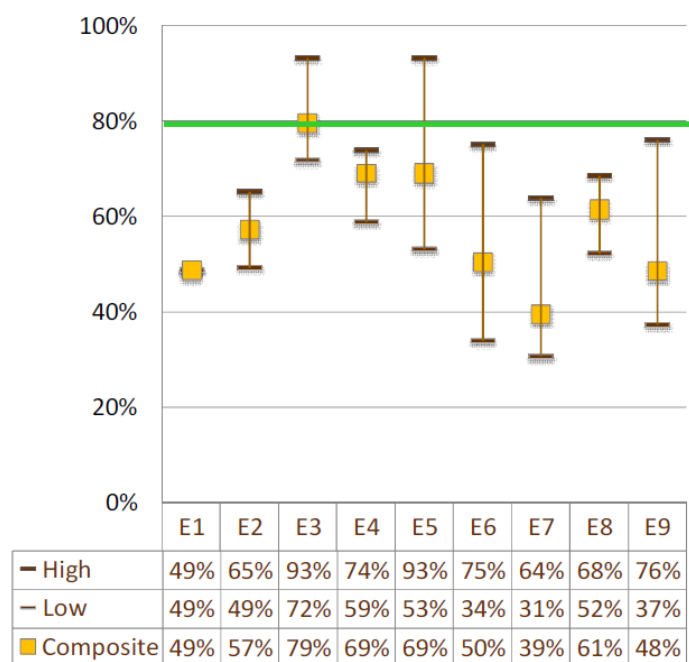
National vaccine stock-outs are said to be blamed for the drop in immunization coverage around the mid-2010s (7,56). Global shortages of the pentavalent vaccine (containing DTP, Hepatitis B, and *H. influenza* type B) were occurring at around that time (57), but this was not the only cause for stock-outs in the Philippines: Ulep and Uy conclude from an analysis of DOH Procurement Monitoring Reports that unsuccessful tender bidding is an ongoing problem and has resulted in procurement failures especially from 2014 onwards (54). This would coincide with reporting from the WHO that in non-Gavi MICs that procure their own vaccines, national stock-outs are most often due to procurement delays (Figure 4.1) (33).

Figure 4.1 Causes of national stock-out by income group, 2016 (33)



There are also weaknesses in the vaccine supply chain. WHO and UNICEF launched the Effective Vaccine Management (EVM) initiative to help countries measure and evaluate their vaccine supply chains (58). According to the 2017 EVM assessment (Figure 4.2), the Philippines has adequate storage capacity and acceptable cold chain infrastructure that is relatively well maintained (59). But, there is ineffective distribution and stock management, and arrival procedures, information systems, and supportive management functions also require improvement (59).

Figure 4.2 Philippines Effective Vaccine Management assessment scores, 2017 (59)

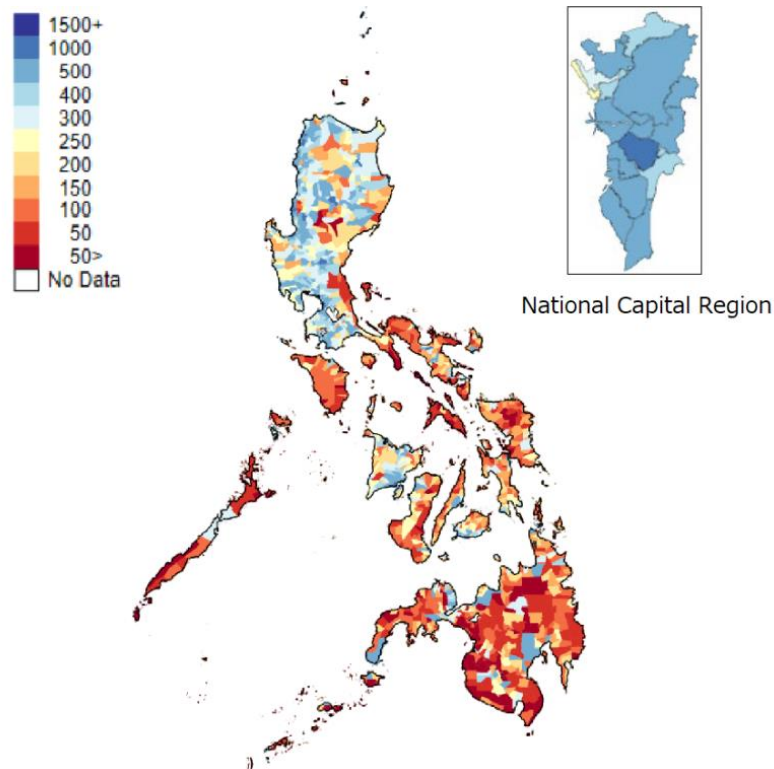


The nine areas (criteria E1-E9) of effective vaccine management are: E1 Vaccine & commodity arrival procedures, E2 Vaccine storage temperatures, E3 Cold & dry storage capacity, E4 Buildings, cold chain equipment & transport, E5 Maintenance, E6 Stock management, E7 Effective distribution, E8 Good vaccine management practices, E9 Information systems and supportive management functions

Workforce

A health worker density of 1.5 workers per 1,000 population has been associated with 80% measles immunization coverage (60). Although further research has revealed that the relationship between the health workforce and vaccine coverage is complex and a focus on per capita levels of human resources may be of limited value, there is empirical evidence of a positive relationship (61–63). Most recently, the WHO has identified 4.45 doctors, nurses, and midwives per 1,000 population as the threshold to meet UHC and Sustainable Development Goals-related targets (64). As of 2015, the Philippines is approaching this level at 4.1 per 1,000 population, but maldistribution within the country is persistent (27,65). Health workers are concentrated in the northern part of the country and urban areas (Figure 4.3) (65), which could partly explain the urban-rural gap in vaccine coverage rates.

Figure 4.3 Doctors, nurses and midwives per 100,000 population by residence, 2015 (65)



I would like to touch upon the topic of international health worker migration. The Philippines is a major global exporter of health workers, especially nurses: There are sources that state the Philippines leads the world in exporting nurses and reports that up to 85% of Filipino nurses work overseas (66–68). This phenomenon reflects the unstable domestic socioeconomic situation, historical and political circumstances, globalisation, and the demand for health care in rapidly ageing developed countries (69,70). Some claim that the reduced availability and quality of health care services, especially in rural areas, is a negative consequence of this mass workforce exodus (69,71).

Systematic reviews report that community health workers (CHW) can contribute to raising vaccine coverage (72,73). Other than by reinforcing the workforce, the pathways in the framework through which their work is effective are by facilitating smoother community access and positively influencing attitudes and norms. There is a long-running CHW system in the Philippines called the Barangay (village) Health Worker (BHW) system. BHWs work from barangay health stations and are supervised by midwives; The midwives, in turn, receive supervision from public health nurses at health centres and rural health units (74). BHWs can be trained to identify and record children in their catchment areas eligible for vaccination (75). Due to the decentralisation of health services, variations have been observed in the quality and effectiveness of BHW programs (76).

Facility Readiness

Financing, leadership and governance, and service delivery – three of the other health system building blocks – are also essential determinants in the Philippines. The DOH finances 95% of the immunization program; it is responsible for procuring vaccines, maintaining the cold chain, and training health workers, whereas LGUs cover the operational expenses for service delivery at local facilities (77). The Sin Tax is a tax on tobacco and alcohol earmarked for health care. The Sin Tax Reform of 2012 has successfully generated revenue for expanding the immunization program (77). However, there is a backlash against allocating Sin Tax revenue to immunization, as these incremental funds are mainly being used to cover the rising costs of new vaccines (54,77). 70% of spending on vaccines in 2018 and 2019 was used to obtain PCV and HPV (54). PCV is only available in selected regions, and HPV is recommended but not yet part of the national program (78).

The decision-making around financing and introduction of new vaccines is unclear, and in a report on sustainable immunization financing in the Philippines, Coe et al. assert that this confusion comes from the absence of a National Immunization Technical Advisory Group (NITAG) (77). A National Immunization Committee (NIC) was established in 1986, but a source states that it was dissolved in the early 2010s (79). It appears to have been reorganised lately following the dengue vaccine controversy (80). The very little information implies that it has not been functioning effectively. Ulep and Uy, in their assessment of the EPI, also allege that there is a lack of leadership in addressing the reoccurring problem of stock-outs and ongoing low coverage and that the DOH is not investing enough in health system strengthening or the supply chain (54). There does seem to be a need for stronger leadership and better governance.

The Local Government Code was introduced in 1991, and basic services, including health services, were devolved to LGUs; decentralisation was seen as the answer for improving service delivery and health outcomes for the highly diverse populations throughout the archipelago. Grundy et al. report that, contrary to expectations, decentralisation has been detrimental for the quality and coverage of health services, especially in rural and remote areas (81). Other studies have documented how LGUs have struggled to implement malaria control programs (82) and reproductive health programs (83), and earlier, I alluded to how decentralisation affects BHW programs (76). I was not able to find any research about how decentralisation has impacted immunization coverage in the Philippines, but I will come back to this topic again in the section on community access.

Natural disasters must not be forgotten. After super typhoon Yolanda hit the Philippines in 2013, routine immunization services were disrupted in 54 facilities in 35 municipalities for a median duration of eight weeks (84). In some areas, the interruption continued for more than three months. Disaster-resilient cold chain equipment and well-established contingency operation plans for maintenance and replacement of supplies in the event of a disaster were identified as

key criteria for successful program recovery (84). At the time, Yolanda was the strongest tropical cyclone at landfall on record, but Meranti equalled it in 2016, and Rolly overtook both in 2020 (85).

Facility readiness is not only a direct determinant of vaccine coverage, but unreliable service can also negatively influence people’s attitudes, perceived norms, and perceived control, hence lowering their intent to vaccinate.

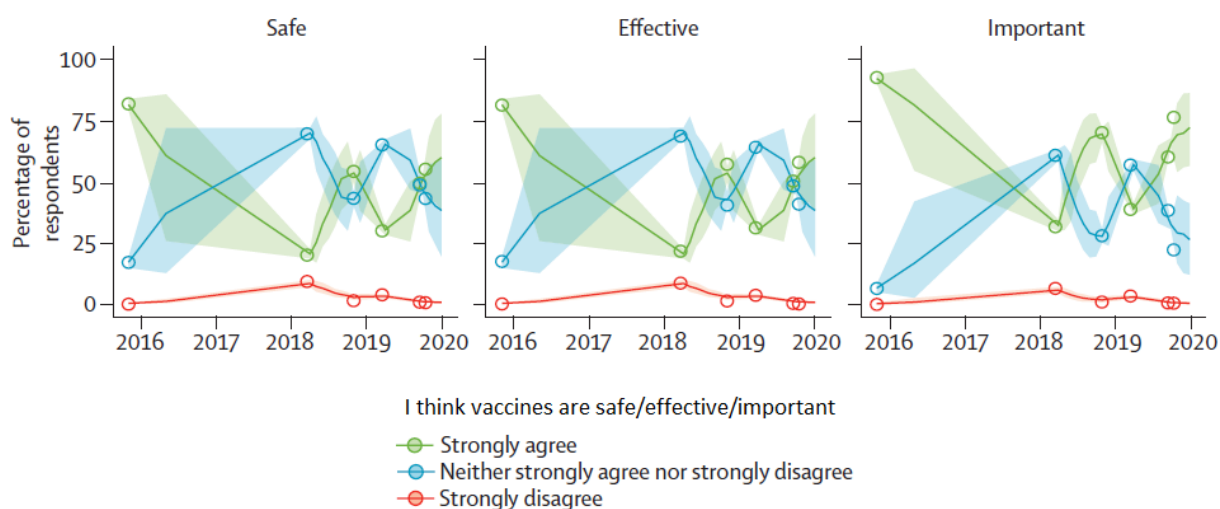
Intent to Vaccinate

The TPB assumes that behavioural intention is the most important determinant of behaviour (44). In the following sections, I will explore Filipino’s attitudes and beliefs about vaccines, and the socioeconomic, cultural, and environmental factors that influence them.

Attitudes

In 2015, the Philippines ranked in the top ten countries worldwide for confidence in the safety, effectiveness, and importance of vaccines (22). In 2017, due to the dengue vaccine scare, they experienced a considerable fall (22). Although vaccine confidence plummeted due to this crisis, in more recent years, it does seem that recovery is being made (Figure 4.4) (22).

Figure 4.4 Trends in attitudes towards vaccines in the Philippines 2016-2020 (22)



Yu et al. conducted interviews with low- and middle-income Filipinos and health workers across urban and rural Philippines in order to understand their perspectives of the Dengvaxia panic (86). They document the fear towards vaccines felt by community members and how this spilled over into mistrust of other government health programs and authority in general (86). They discovered an urban-rural divide, with more favourable sentiments towards vaccinations in rural communities where the controversy was seen as something that happened in urban areas (86). A finding that provides optimism was that the measles outbreak of 2018 and 2019 appeared to be a

turning point (86). Although people maintained a degree of wariness towards vaccines, especially the dengue virus vaccine, they began to reaccept at least those vaccines already included in the EPI (86).

Dayrit et al. examine the Dengvaxia controversy and raise negative news coverage and communication gaps among stakeholders as the main factors responsible for the crisis (21). An increase in vaccine hesitancy after media coverage of adverse events following immunization has also been observed in China regarding the Hepatitis B vaccine (87) and in Vietnam with Quinvaxem, a pentavalent vaccine (88). In a modern world where information is becoming more widely available, many recognise the need for new and better methods of communication, dialogue, and engagement across all stakeholders in order to build and maintain public trust in vaccines (21,89).

The DHS also gathers information on women's exposure to mass media and internet use along with health statistics. The 2017 DHS revealed that watching television remains the most common form of mass media exposure, with close to 80% watching at least once a week (25). As for the internet, almost 70% had access, and among these women, more than half of them went online every day and another 30% at least once a week (25). Other sources estimate internet penetration in the Philippines ranges from 49-82% of the population (90,91). A notable statistic regarding internet use is that Filipinos, on average, spend over four hours on social media; they have been topping the global rankings for the past few years (92). 87% of adults are estimated to be mobile phone users (93). These trends could influence attitudes about vaccines and have implications for health information dissemination strategies.

Finally, I would like to bring up the subject of maternal education and childhood immunization. This link exists in many countries, although the effects are reduced when controlled for socioeconomic status and residence (94). In other words, children of educated mothers are more likely to be immunized partly because they live in wealthier households and in areas where other children are immunized. Other causal pathways are less-studied, but a study in India found that increase in health knowledge and communication skills could be important mechanisms (95). Women learn health knowledge at schools and they also acquire academic skills, notably literacy, which enables them to become more receptive to health information through sources such as mass media (96). Better communication skills increase a mother's ability to navigate the health system and gain access to vaccines for her children (95).

Perceived Norms

According to the TPB, norms reflect beliefs about whether key people approve or disapprove of the behaviour and motivation to comply with those recommendations (44). To measure perceived norms, researchers might ask parents how much they agree to a statement such as "most people who are important to me think that children should get vaccinated" (97). Regarding routine childhood immunization, it would be assumed that the opinions of family,

friends, community members, and health workers would carry weight.

A social group in the Philippines with the ability to influence norms is the Church. The Philippines had previously experienced a vaccine controversy that demonstrated this. In the 1990s, Human Life International, a Roman Catholic pro-life organisation, played a part in spreading false rumours that the tetanus vaccine contained contraceptives (89,98). This misunderstanding arose as the use of tetanus toxoid as a carrier protein was mentioned in a research article about a birth control vaccine (99). Human Life International spread this misinformation to members in more than 60 countries, and in the Philippines, this led to a temporary court injunction on the tetanus vaccination campaign and a drop in coverage rates (89,98). The extremely high levels of trust that the Church has maintained over the years also presents opportunities (100). During the current coronavirus disease 2019 (COVID-19) pandemic, the Catholic Bishops' Conference of the Philippines has been cooperating with the DOH to help build confidence in the government's vaccine rollout (101).

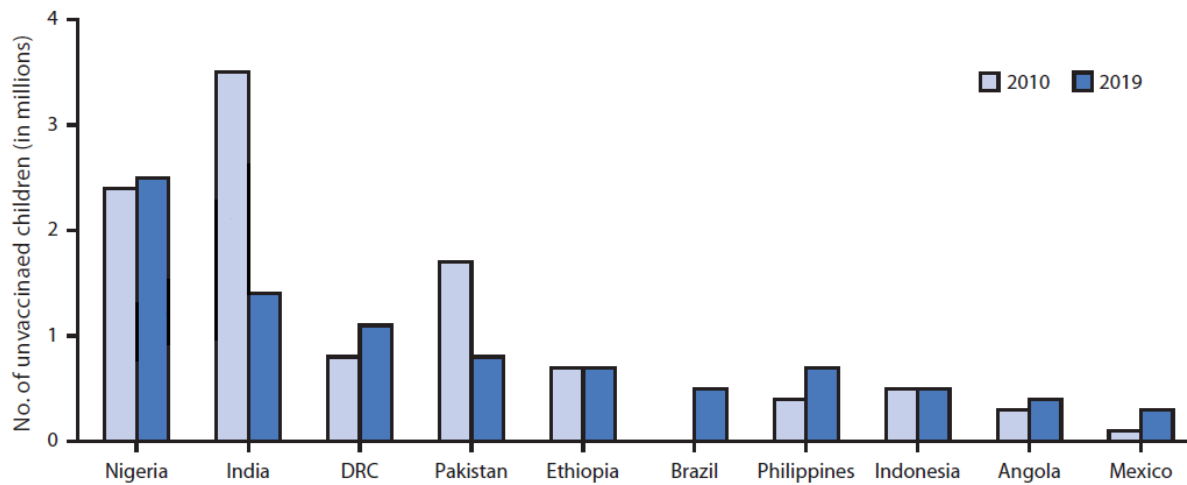
Perceived Control

Studies using the TPB to explain vaccination behaviour have found that positive attitudes are the strongest predictor of intent to vaccinate followed by subjective norms, and perceived behavioural control, though associated, was the weakest indicator (97,102–104). These studies are conducted in high-income countries but in LMICs, perceived control could be a more influential determinant. Distance to a health facility, scarcity of resources due to poverty, and insecurity due to conflict are barriers that would come under community access. Still, they could also contribute to a sense of lack of control over vaccination behaviour.

Community Access

Access is a complex notion with a variety of interpretations (105). Though the meaning of access differs from the sense that it is used in my guiding framework, zero-dose children are considered a marker of access to immunization (106). Reaching these children is one of the strategic priorities of Gavi (107) and the World Health Assembly endorsed Immunization Agenda 2030 (108). The number of estimated zero-dose children in the Philippines is alarming (Figure 4.5) (29). Only Nigeria and the Democratic Republic of the Congo have a higher prevalence among the ten countries with the most zero-dose children. Moreover, the numbers are increasing. This increase in zero-dose children over the past decade may be due to availability issues caused by the supply problems I explained earlier. The numbers for 2019 could also reflect the period when vaccine hesitancy levels were extremely high after the dengue vaccine controversy. Still, the large number of zero-dose children is a sign that many face barriers between intent and readiness in the Philippines.

Figure 4.5 Estimated number of zero-dose children among the ten countries with the most zero-dose children, 2019 (29)



DRC: Democratic Republic of the Congo

Reviews of both published literature on LMICs (109) and grey literature worldwide (110) exploring reasons related to non-vaccination found distance to services and poor access was the most commonly identified reason. This is probably another factor behind the low immunization rates in rural areas of the Philippines. Reaching Every District (RED), the WHO African Region’s strategy for strengthening immunization systems, was introduced in the early 2000s (111). One of the five original components was “re-establishing outreach services”. An evaluation of the RED approach in nine countries reported that this was the most widely recognised and applied component (112). According to the DOH website, the Philippines adopted the RED approach in 2004, calling it Reaching Every Barangay (REB), and lists it at the top of their list of EPI strategies (113). The same page also states that all health centres and barangay health stations have at least one staff member trained on the REB strategy (113). I also came across mentions of this REB strategy in other sources (114,115) but was not able to locate any detailed information or literature assessing its implementation status or effectiveness.

Conflict can cause health system collapse and directly impact facility readiness, and through the resulting insecurity have adverse effects on access. A spatial analysis of infant immunization coverage in Afghanistan found that regardless of the availability of resources, lack of security and immunization coverage were negatively associated (116). In a study on adherence to EPI in Lanao del Norte, Northern Mindanao (Region X), the Philippines, many respondents raised safety concerns as barriers to immunization (115). Lanao del Norte is a province with high numbers of clan conflict incidences, and some respondents were afraid of going to health centres because of these feuds (115). Lanao del Norte borders ARMM, the latter being an insecure region plagued by violence and conflict, including attacks on hospitals (117,118), with the lowest vaccine coverage in the country (25). The Philippines fits the pattern observed by Grundy and Biggs, who analysed immunization coverage in countries with large displaced populations: lower national

rates driven by pockets of very low coverage in regions affected by conflict (119).

Along with rural and remote populations and conflict-affected populations, another group of people who have restricted access to immunization services is the urban poor. Other factors such as poverty, low education levels, and migrant status also interact with service access to lower vaccine uptake in slums (120). As of 2018, 47% of the Filipino population live in urban areas(121), and 44% of these city dwellers live in slums (122). When combined with suboptimal immunization rates, lack of hygiene, malnutrition, and overcrowding in slums make for a high-risk environment for VPD outbreaks (123). This has been illustrated in the Philippines with measles and diphtheria outbreaks in 2014 and 2015 with high caseloads in the National Capital Region (124). It is also telling that the cVDP cases reported in the Philippines in 2019 were from ARMM and Manila (15).

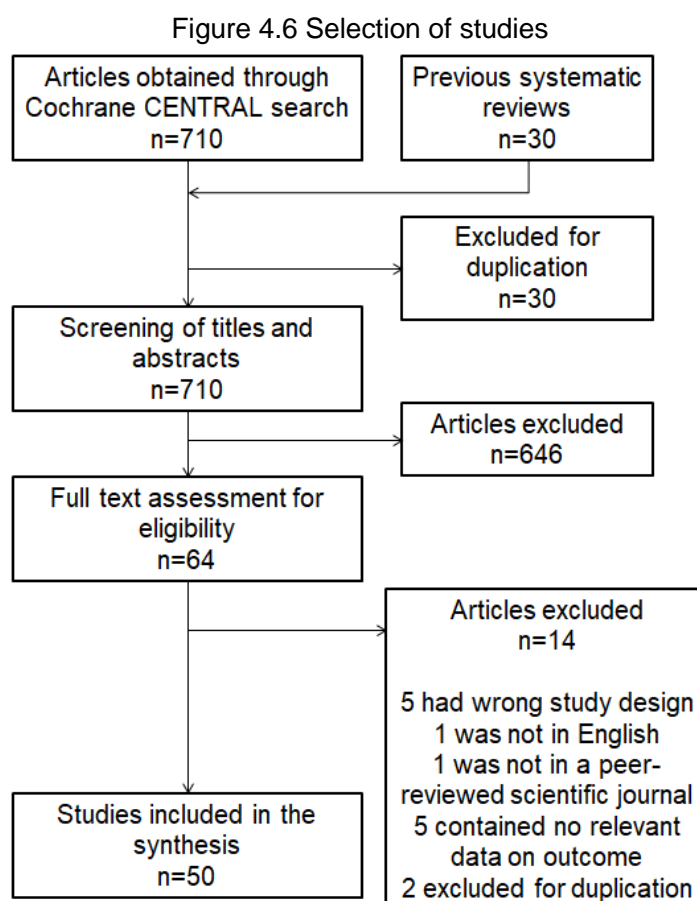
According to the National Immunization Program Manual of Operations, a Reaching Every Purok (REP) strategy – a barangay is divided into smaller zones known as puroks – was introduced in 2013 as the next step after the REB strategy (125). The manual says that this strategy is designed for densely populated areas and informal settlements with a lot of population movement and migration (125). It consists of identifying and mapping high-risk areas through home visits and regular monitoring (126). A UNICEF report suggests that lack of documentation regarding baseline statistics and potential impact indicates that this policy is not being driven or followed up by sufficient research and evaluation efforts; the report also points out that it is not clear how LGUs are made accountable for financing and results (124).

This brings us back to the subject of decentralisation. A lack of management ability at the local level has been recognised as one of the obstacles to successful decentralisation in the Philippines (127,128). I came across a case that suggests an association between lack of local management capacity and immunization coverage. The DOH runs a program to train local health officials to build management skills (128). Participants return to their workplace as part of this training and implement a process improvement project. In a paper evaluating this program, one of the examples of projects carried out is a case where full immunization rates were improved from 38% to 92% in the municipality of Tarangnan, Samar, Region VIII (128).

4.2 Interventions to improve vaccine coverage in LMICs

Study selection

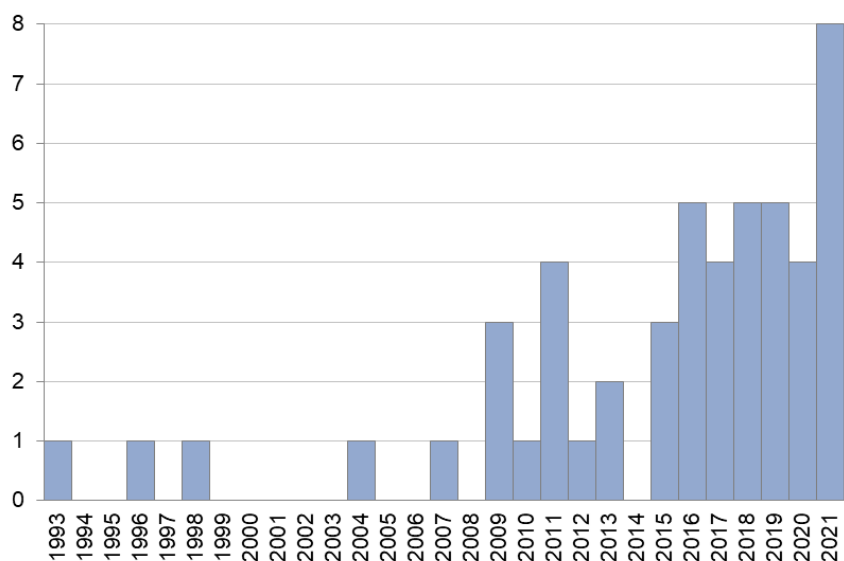
A search of Cochrane CENTRAL yielded 710 citations. I identified 30 records from previous systematic reviews (36,48–51). After removing 30 duplicate records, there were 710 articles for title and abstract screening. Of these, 646 did not meet the inclusion criteria. The full texts of the remaining 64 articles were retrieved for detailed review. Fourteen articles were excluded after full-text evaluation, and 50 studies were included in the synthesis (Figure 4.6).



Study characteristics

There were 43 randomised trials (27 cluster randomised trials and 16 individually randomised trials), three non-randomised trials, and four controlled before-after studies, published between 1993 and 2021 (Figure 4.7). They were conducted in Afghanistan (n=1), Bangladesh (n=1), Cameroon (n=1), China (n=2), Ethiopia (n=1), Georgia (n=1), Ghana (n=2), Guatemala (n=3), Honduras (n=1), India (n=11), Indonesia (n=1), Iraq (n=1), Kenya (n=4), Mali (n=1), Nepal (n=1), Nigeria (n=7), Pakistan (n=5), Republic of Congo (n=1), Rwanda (n=1), Turkey (n=1), Zambia (n=1), and Zimbabwe (n=2).

Figure 4.7 Number of studies by year of publication



Interventions

The interventions were targeted at recipients, providers, and the health system, and many were multi-component interventions. Table 4.1 presents the number of studies categorised by the main intervention component. In the following pages, the studies are summarised by intervention type. Note that studies looking at multi-component interventions are introduced multiple times.

Table 4.1 Number of studies by main intervention component

Target	Intervention	Studies
Recipients	Reminder and recall	19
	Community-based health education	6
	Facility-based health education	2
	Health education through mobile devices	2
	Cash transfers	2
Providers	Digital intervention to support providers	1
	Supportive supervision	1
Health system	Home visits	6
	Outreach services	4
	Performance based financing	4
	Integration with other services	2
	Vaccine vials with fewer doses	1

Reminder and recall interventions

In addition to the 19 studies with reminder and recall interventions as their main component, there was one more study with a reminder as an important sub-component, and they are summarised in Table 4.2.

The most common type of reminder was short message service (SMS) texts; There were nine studies that compared them to routine care (129–137). The interventions varied in the number and timing of the SMS texts and whether follow-ups were sent for those who did not show up. In studies in Guatemala by Domek et al. (129) and in Ethiopia by Mekonnen et al. (134), an SMS text reminder system was designed for the study. In Kenya, Gibson et al. used a free, open-source platform to send the SMS texts (130), and in India, Seth et al. used a cloud-based software platform (135). The study in Kenya by Haji et al. mentions using an automated system to send reminders, but the details are unclear (131). The study in Nigeria by Kawakatsu et al. tested a system developed by the state government (133), the study in India by Shinde et al. utilised a program of the Indian Academy of Paediatrics (136), and the study in Bangladesh by Uddin et al. adapted an app created by the Ministry of Health and Family Welfare (137). For the study in Nigeria by Ibraheem et al., it is unclear whether an automated system was used to send the reminders (132). Only three studies did not observe a positive impact on coverage in the intervention group (129,130,135). For two of these studies, this may have been because of high baseline coverage (129,130).

Two of these trials also compared SMS text reminders to other interventions (131,132). Haji et al. found that those who received SMS text reminders were more likely to return for their shots compared to those receiving routine care, but reminder stickers did not make a difference (131). Ibraheem et al. compared call reminders, SMS text reminders, and SMS texts with immunization facts to routine care (132). All the intervention groups were more likely to complete their immunizations compared to the control group, with SMS texts with information facts appearing less effective than reminders (132).

Another three trials assessed a multi-component approach including SMS text reminders (138–140). Bangure et al. found SMS text reminders in combination with health education to be more effective than only health education (138). Ekhaguere et al. sent SMS text plus automated call reminders in a rural area of Nigeria with low literacy and observed a rise in coverage rates compared to routine care (140). In a study by Chen et al. in rural China, SMS text reminders were sent to all participants, but in the intervention group, village doctors used an app that enabled them to keep records and track children (139). There was no statistically significant difference in coverage between the groups, but interviews revealed that the doctors felt the app was convenient and saved time (139).

Five studies used calls as reminders (132,140–143). Brown et al. (141) and Ibraheem et al. (132), both in Nigeria, and Levine et al. in Ghana (142) found call reminders to be effective in raising coverage compared to routine care. In the study in Ghana, study staff made the calls (142),

Table 4.2 Summary of reminder and recall interventions

Author, year	Country	Trial type	Type of reminder	Notes on intervention and/or other components	Outcome measure regarding immunization	Results*
Bangure, 2015 (138)	Zimbabwe	individually randomised	SMS text	Health education offered to all, and SMS text reminders sent only to intervention group.	Receipt of scheduled vaccines at 6, 10, and 14 weeks.	Higher coverage in intervention group.
Brown, 2016 (141)	Nigeria	cluster randomised	call	Also looked at training immunization providers. One intervention arm was only call reminders, one was only training for providers and one was both interventions.	Routine immunization completion at 12 months of age	Children in intervention groups were more likely to be immunized, but the increase was marginal for the provider training only group.
Busso, 2015 (144)	Guatemala	cluster randomised	through CHWs	CHWs received lists of children due to receive a vaccine in the following month in the intervention group.	Receipt of all vaccines recommended for age	Increased probability of vaccination completion in intervention group.
Chen, 2016 (139)	China	cluster randomised	SMS text	Everyone received SMS text reminders, but doctors in the intervention group used an app to keep records and track children	Full vaccination coverage with all recommended vaccines	No difference in coverage increase between groups.
Domek, 2019 (129)	Guatemala	individually randomised	SMS text	SMS text reminders sent to intervention group.	Second and third visit completion of immunization series	No difference in visit completion, but intervention group visits were more timely
Ekhaguere, 2019 (140)	Nigeria	individually randomised	automated call, SMS text	Automated call and SMS text reminders sent to intervention group.	Receipt of three pentavalent vaccines and measles vaccine at 12 months of age	Higher coverage in intervention group.
Gibson, 2017 (130)	Kenya	cluster randomised	SMS text	Also looked at the effectiveness of providing incentives in the form of money transferred through mobile phones.	Fully immunized children	Only the group that received a larger incentive had higher coverage.
Haji, 2016 (131)	Kenya	cluster randomised	SMS text, stickers	The first intervention arm was SMS text reminders and the second was stickers.	Return for the third dose of pentavalent vaccine	Those who received SMS text reminders were less likely to drop out, but stickers did not make a difference.
Ibraheem, 2021 (132)	Nigeria	non-randomised	call, SMS text	The intervention had three arms; call reminders; SMS text reminders; and educational SMS texts.	Receipt of all scheduled vaccinations over five appointments	Intervention groups more likely to be immunized, with higher odds in call and SMS text reminder groups.
Kawakatsu, 2020 (133)	Nigeria	individually randomised	SMS text	SMS text reminders sent to intervention group.	Return visits for upcoming vaccination appointments.	The return rate in the intervention group was higher.

Levine, 2021 (142)	Ghana	cluster randomised	call, through CHWs	The first intervention arm was call reminders. The second was incentives to CHWs and households using mobile phone-based banking apps.	Completion of polio vaccine within 14 days and BCG vaccine within 28 days of birth	Both interventions increased coverage compared to the control, incentives to a larger degree than call reminders.
Mekonnen, 2021 (134)	Ethiopia	individually randomised	SMS text	SMS text reminders sent to intervention group.	Receipt of all recommended vaccinations by the age of 12 months	Higher coverage in intervention group.
Nagar, 2018 (143)	India	cluster randomised	NFC pendant, automated call	The study had three arms; NFC sticker (control); NFC pendant; and NFC pendant with voice call reminder.	3 rd DTP vaccination within 2 months from 1 st DTP administration	No difference in coverage between groups, but there was a failure in the implementation of the automated call system.
Seth, 2018 (135)	India	individually randomised	SMS text	Also looked at incentives to caregivers in the form of phone talk time.	Number of vaccines received by a child divided by the number of vaccines required for the child for their age	Coverage increase for the group with SMS text reminders and incentives but not for the group with only SMS text reminders.
Shinde, 2018 (136)	India	individually randomised	SMS text	SMS text reminders sent to intervention group.	Immunization at 6 th and 10 th week (details unclear)	Higher coverage in intervention group.
Siddiqi, 2020 (145)	Pakistan	individually randomised	silicone bracelet	A hole was perforated in the bracelet when the child received immunizations to record vaccine administration.	Receipt of 3 rd pentavalent and 1 st measles vaccine at 12 months of age	No difference in coverage between groups.
Uddin, 2016 (137)	Bangladesh	non-randomised	SMS text	SMS text reminders sent to intervention group.	Full vaccination with all recommended vaccines at 9 months	Greater coverage increase in intervention group.
Usman, 2009 (146)	Pakistan	individually randomised	redesigned immunization card	Also looked at the effectiveness of facility-based health education.	Visit for 3 rd DTP vaccine during a 90-day follow-up	Higher coverage in all intervention groups.
Usman, 2011 (147)	Pakistan	individually randomised	redesigned immunization card	Whereas the Usman, 2009 study was in an urban area, this study was in a rural area.	Visit for 3 rd DTP vaccine during a 90-day follow-up	Higher coverage in all intervention groups.
Wallace, 2019 (148)	Indonesia	cluster randomised	HBR, stickers	The first intervention arm was HBR only and the second was HBR plus stickers.	Receipt of the 3 rd dose of DTP vaccine within 7 months	No difference in coverage between groups.

*Statistically significant result regarding measure in previous column, according to the authors.

SMS: short message service, CHW: community health worker, NFC: near field communication, HBR: home-based records, DTP: diphtheria and tetanus toxoids and pertussis-containing vaccine

and for the studies in Nigeria, it is not clear who was making the calls (132,141). Ekhuere et al., also in Nigeria, observed an increase in coverage with SMS text plus automated call reminders (140). In India, Nagar et al. also tried combining automated call reminders with other approaches, but there was a failure in the implementation of the call reminder system (143).

Reminder stickers were ineffective in raising coverage in two studies (131,148). In a trial by Haji et al., caretakers were given two stickers that noted the day of the scheduled vaccination and the name of the health facility and instructed to place one on the child's health booklet and the other in a visible area of the household (131). Wallace et al. conducted a trial in Indonesia where a reminder sticker for the next visit was stuck on the front of the home-based record (148).

A study by Siddiqi et al. in Pakistan using silicone bracelets as a reminder and a way of recording vaccination showed no positive impact on coverage (145). When the child received a vaccine, a hole was perforated in a designated part of the bracelet to record administration (145). Similarly, Nagar et al. hypothesised that a pendant on a black thread, believed to ward off evil spirits in tribal regions of India, could act as a reminder and promote discussion about immunization within families and communities (143). This pendant was also a near field communication (NFC) device that immunization providers could scan to bring up the infant's vaccination history. Having the pendant did not increase vaccination rates compared to the control group, which had NFC stickers on their immunization cards (143).

Simply offering a home-based record to a caregiver if they did not have one did not increase coverage in Indonesia (148) but redesigning immunization cards raised coverage in urban and rural settings of Pakistan (146,147). Usman et al. redesigned the small card being used, making it bigger, clearly indicating the next vaccination date in large font on the cover, and providing a plastic jacket with a hanging string (146,147).

Interventions to Inform and educate

I have summarised the 14 studies for which the objective of the main intervention component was to inform and educate in Table 4.3.

The six trials that evaluated community-based health education interventions were quite varied in character (149–154). Pandey et al. hypothesised that, in rural and impoverished areas of India, lack of awareness about entitled services was leading to poor utility (153). They held public meetings to inform villagers about health and education services and village governance (153). A study by Andersson et al. in Pakistan tested a strategy of structured discussions facilitated by pre-trained community members (150). These discussions sometimes led to action plans such as sharing transport to vaccination points and providing care for children while parents took others to be vaccinated (150). Abdul Rahman et al. in Iraq (149) and Oyo-Ita et al. in Nigeria (152) tested strategies involving traditional and religious leaders as advocates for routine immunization. The approach taken by Oyo-Ita et al. was more intensive as they offered traditional and religious leaders training, plus they trained health care workers to improve their communication of

Table 4.3 Summary of interventions to inform and educate

Author, year	Country	Trial type	Type of intervention	Brief description	Outcome measure regarding immunization	Results*
Abdul Rahman, 2013 (149)	Iraq	controlled before-after study	community-based health education	Health education activities lasting for 3 hours and including lectures, posters and a video were held. Religious leaders involved in intervention villages.	Coverage rates of each of 3 doses of DTP and measles vaccines.	Coverage became higher in the intervention villages for 2 nd and 3 rd DTP and measles shots.
Andersson, 2009 (150)	Pakistan	cluster randomised	community-based health education	Intervention was evidence-based, structured community discussions about the costs and benefits of vaccination facilitated by pre-trained community members.	Measles and full DTP vaccinations of children aged 12-23 months.	Intervention clusters were more likely to be vaccinated.
Bolam, 1998 (155)	Nepal	individually randomised	facility-based health education, home visits	There was a control arm and three intervention arms: health education after birth at hospital and three months later at home, at birth only, and at three months only	Proportion of children with all appropriate immunizations at 6 months	No difference in coverage between groups
Chakraborty, 2021 (156)	India	individually randomised	health education through mobile device	Audio messages about health topics were delivered weekly from the 12 th week of pregnancy up until the child's first birthday for the intervention group; 11 of them were about immunization.	Full immunization (basic: 8 vaccines and comprehensive: 19 vaccines)	Intervention was not associated with an increase in coverage.
Hu, 2017 (157)	China	individually randomised	facility-based health education	The intervention group were given a prenatal 15-minute one-on-one interactive vaccination education session.	Vaccination status at 12 months of age	Full vaccination coverage was higher in the intervention group.
Maldonado, 2020 (151)	Kenya	cluster randomised	community-based health education	Intervention groups joined a community health volunteer-led, group-based health education programme for pregnant and postpartum women.	Completion of infant immunization series by 12 months of age.	Intervention group was more likely to complete immunizations.
Murthy, 2019 (158)	India	non-randomised	health education through mobile device	Intervention group received voice messages on infant care twice per week throughout pregnancy and until their infant turned one year of age.	Receipt of all recommended vaccines	Intervention group was more likely to be fully immunized

Omer, 2021 (159)	Nigeria	cluster randomised	home visits	Home visitors visited pregnant women and their spouses every 2 months during pregnancy in the intervention group, informing them about prevention and management of diarrhoea and immunization.	Whether the child had received all routine vaccines at 12-18 months.	No difference in coverage between groups.
Owais, 2011 (160)	Pakistan	individually randomised	home visits	The intervention, administered by trained community health workers, consisted of three targeted pictorial messages regarding vaccines.	Completion of 3 doses of DTP/Hepatitis B vaccine 4 months after enrolment	Higher coverage in intervention group.
Oyo-Ita, 2021 (152)	Nigeria	cluster randomised	community-based health education	The intervention included: training of traditional and religious leaders, training of health care workers to improve their communication of vaccination data with laypersons, community engagement, and strengthening of the local development committees.	Proportion of children aged 0-23 months fully up-to-date with vaccination	No difference in coverage between groups.
Pandey, 2007 (153)	India	cluster randomised	community-based health education	Four to six public meetings were held in each intervention village cluster to disseminate information on entitled health services and village governance requirements.	Proportion of infants who received more than one vaccination.	Greater coverage increase in intervention group.
Powell-Jackson, 2018 (161)	India	individually randomised	home visits	Mothers in the first intervention arm received information framed as a gain, and the second received information framed as a loss.	Proportion of children who had received 3 rd dose of DTP measured after 7 months of follow-up.	Intervention had higher coverage than control but no difference between the two intervention groups.
Sato, 2021 (162)	Nigeria	individually randomised	home visits	The intervention group was provided with tailored information on their children's current vaccination status and the next schedule for vaccination, while the control group was provided with generic information.	Full vaccination rate according to records at health clinic (details unclear)	Intervention did not increase the odds of full vaccination.
Vaidyanathan, 2019 (154)	India	cluster randomised	community-based health education	School students with under-five children in their own household or immediate neighbourhood attended 6-day sessions of information, education and communication strategy	Immunization status (full, partial, or not immunized) according to immunization card (details unclear)	Intervention was associated with an increase in full immunization coverage.

*Statistically significant result regarding measure in previous column, according to the authors
DTP: diphtheria and tetanus toxoids and pertussis-containing vaccine.

vaccination data with laypeople, held routine community meetings, and strengthened local development committees (152). Vaidyanathan et al. in India enlisted school students with under-five children in their own household or immediate neighbourhood and taught them to promote immunization (154). The study by Maldonado et al. in Kenya evaluated the effect of a community-based women's health education group on maternal and child health outcomes (151). In all but one study (152), the interventions showed improvements in vaccination coverage.

Health education through home visits was explored in four trials, and there were again differing approaches (159–162). In a trial by Omer et al. in Nigeria, trained home visitors visited pregnant women and taught them about immunization and the prevention and management of diarrhoea (159). Intervention households had better hygiene and decreased diarrhoea incidence but no increase in vaccination coverage (159). The authors thought this may have been because of poor access to health services (159). Owais et al. found that educating mothers with targeted pictorial messages about immunization during home visits increased coverage in a low-literacy community in Pakistan (160). Powell-Jackson et al. observed that home visits had a positive impact on immunization rates, but there was no difference whether information was framed as a gain (child is more likely to be healthy if vaccinated) or as a loss (child is more likely to suffer ill health if not vaccinated) (161). Sato et al. tried providing caregivers with tailored information on their children's current vaccination status and the next appointment instead of general information (162). They found an increase in clinic visits immediately after the home visits in the tailored information group but no increase in full coverage, leading them to conclude that it is important to constantly remind caregivers about vaccination schedules in a timely manner (162).

The two studies looking at education through mobile devices were similar (156,158). Both were set in India and assessed established mobile communication services that sent participants regular voice messages about infant care and health topics throughout their pregnancy until the infant's first birthday. Chakraborty et al. studied a rural population with low literacy rates and saw no association between the intervention and immunization rates (156). Murthy et al. targeted slums and low-income areas in Mumbai and saw an improvement in immunization coverage in the intervention group (158).

Bolam et al. offered mothers health education after birth at hospital and three months later at home, either, or neither, and found no difference in coverage rates between groups (155). They comment that they may not have detected a difference because coverage rates were higher than estimated (155). Another study about facility-based health education focused on the prenatal period (157). Hu et al. found that a prenatal interactive vaccination education session increased coverage (157).

Incentives and cash transfers (CT)

Three trials showed incentives delivered through mobile devices in combination with reminders to be effective in improving immunization coverage (130,135,142). A trial by Gibson et

al. found that SMS text reminders only and SMS text reminders plus a 75 Kenya Shillings (KES) incentive did not boost uptake, but increasing the incentive to 200 KES did (130). At the time, 85 KES was around 1 United States Dollar (USD). Seth et al. also found SMS text reminders only didn't make a difference but adding incentives in the form of 30 Indian Rupees (INR) (0.5 USD) of phone talk time did (135). In a study by Levine et al., CHWs were responsible for reminding recipients about vaccine appointments, and 2 Ghana Cedis (0.50 USD) were delivered to both CHWs and caregivers through a mobile phone-based banking app upon verification of vaccination (4). A few studies looked at incentives to health care workers as part of PBF schemes, and these are summarised in the following section.

The studies presented from here onwards are summarised in Table 4.4.

A study by Banerjee et al. found non-financial incentives offered at immunisation outreach camps to be effective in raising immunisation rates (163). The incentives were lentils worth about 40 INR (1 USD) and a set of thalis (metal plates) worth about 75 INR. The incentives were so effective that the cost of immunising one child in the camps with incentives was half that of in the camps without incentives. This study was conducted in a rural area of India where baseline full immunization coverage rates were less than 2%.

Similar to incentives are CT interventions. CT initiatives have been introduced to boost demand for preventive child and maternal health services or as part of social welfare programs for vulnerable children. There were two studies about CT programs (164,165). The study by Morris et al., in rural Honduras, tried to compare CTs with increasing resources to local health teams, but the transfer of resources to health teams could not be adequately implemented (164). A monthly 55 Honduran lempira (3.5 USD) cash voucher was distributed to households. Compared to the control group, a greater proportion of children from households receiving CTs received the first dose of DTP/pentavalent vaccine, but there was no impact on measles vaccination coverage (164). A study by Robertson et al. targeting poor, orphaned, and disadvantaged children in Zimbabwe tried to compare conditional and unconditional CTs but also encountered difficulties with implementation and had inconclusive results (165). Households enrolled in the unconditional CT group collected 18 USD per child every two months. Households in the conditional CT group received the same amount but were monitored for compliance with conditions related to child wellbeing, such as birth registration, up-to-date vaccinations, and attendance at growth-monitoring clinics.

Performance based financing (PBF)

Four studies (166–169) studied the effect that PBF schemes have on immunization coverage. PBF, also known as results based financing or payment for performance, is a health system financing reform that aims to improve coverage and quality of primary care services, often with a focus on maternal and child health. It is thought to be effective because incentives are given for providers to put more effort into specific services, and it increases the resources

Table 4.4 Summary of studies not included in Tables 4.2 and 4.3

Author, year	Country	Trial type	Type of intervention	Brief Description	Outcome measure regarding immunization	Results*
Banerjee, 2010 (163)	India	cluster randomised	Outreach, household incentives	First intervention arm was monthly immunization camps, second arm was camps with incentives	Proportion of children aged 1-3 who were fully immunized	Higher coverage in both intervention groups compared to the control group, higher in the group with incentives
Basinga, 2011 (166)	Rwanda	cluster randomised	PBF	Budgets allocated to the facilities in the control group were increased by the average amount of PBF payments that facilities in the intervention group received.	Proportion of fully immunized children aged 12–23 months	Intervention was not associated with an increase in fully immunized children.
Briere, 2012 (170)	Kenya	controlled before-after study	Integration with other services, household incentives	During routine immunization visits in intervention group, caregivers were offered free hygiene kits and education about water treatment and hand hygiene.	Percent of children who received all due vaccines.	Coverage increase in both intervention and control groups.
Brugha, 1996 (171)	Ghana	cluster randomised	Home visits	Intervention households received home visits using non-health workers	Completion of immunization schedules	Higher coverage in the intervention group
Cristia, 2015 (172)	Guatemala	controlled before-after study	Outreach	Setting was rural districts and in intervention districts services were contracted out to NGOs and provided by mobile medical teams	BCG, 1 st dose of DTP and polio for children aged 2–12 months; measles and boosters for DTP and polio for children aged 12–24 months	Intervention increased coverage for BCG, 1 st dose of DTP and polio, and measles.
de Walque, 2021 (167)	Cameroon	cluster randomised	PBF	Four study groups: (1) PBF, (2) direct financing with additional resources not linked to performance, (3) enhanced supervision and monitoring without additional resources, and (4) a control group.	Receipt of 3 rd dose of polio, meningitis, and measles vaccines	Greater coverage increases for (1) PBF group for 3 rd dose of polio, for (2) direct financing group for meningitis, no difference between groups for measles.
Dicko, 2011 (173)	Mali	cluster randomised	Integration with other services	The intervention consisted of the administration to infants of antimalarial tablets along with vaccines	Proportion of children of 9-23 months who were completely vaccinated	Greater coverage increase in the intervention group

Djibuti, 2009 (174)	Georgia	cluster randomised	Supportive supervision	The intervention consisted of developing guidelines, training district immunization managers in supportive supervision, providing funding, and monitoring and evaluating their activities.	3 rd dose of DTP, OPV, and Hepatitis B coverage rates	Borderline greater increase for 3 rd dose of DTP for intervention group. No difference between groups for 3 rd dose of OPV or Hepatitis B vaccines.
Engineer, 2016 (168)	Afghanistan	cluster randomised	PBF	Intervention primary care facilities implemented PBF scheme.	Receipt of 3 rd dose of pentavalent vaccination	No difference in coverage between groups.
Gokcay, 1993 (175)	Turkey	cluster randomised	Home visits	Compared the performance of CHWs to that of midwives for home visits	Children under 5 years fully immunized (details unclear)	No difference in coverage between groups.
Krudwig, 2020 (176)	Zambia	cluster randomised	Vaccine vials with fewer doses	Control districts used conventional 10-dose measles-containing vaccine vials and intervention districts switched to 5-dose vials.	1 st and 2 nd dose of measles-containing vaccine coverage	Greater coverage increase in the intervention districts.
More, 2017 (177)	India	cluster randomised	Outreach, home visits	Setting was informal settlements in Mumbai and the intervention group received a multifaceted approach.	Proportion of children aged 12–23 months fully immunized	No difference in coverage between groups.
Morris, 2004 (164)	Honduras	cluster randomised	Cash transfers	Compared conditional cash transfers with a direct transfer of resources to local health teams	Receipt of 1 st dose of DTP/pentavalent vaccine and measles vaccine	Greater increase for DTP/pentavalent vaccine in cash transfer group, but no difference for measles vaccine.
Robertson, 2013 (165)	Zimbabwe	cluster randomised	Cash transfers	Households were randomized to conditional cash transfers and unconditional cash transfers.	Proportion younger than 5 years with up-to-date vaccinations	No difference in coverage between groups but study was shortened, and there was contamination between groups.
Sengupta, 2017 (178)	India	cluster randomised	Outreach	Intervention was outreach immunization clinics with provision of community guardians for slum-dwelling migrants.	Full immunization by the age of 1 year	Higher coverage in the intervention group
Zeng, 2018 (169)	Republic of the Congo	controlled before–after study	PBF	Intervention regions implemented PBF scheme.	Receipt of 3 rd dose of DTP	There were reductions in coverage in both intervention and control groups suggesting a vaccine supply issue.

*Statistically significant result regarding measure in previous column, according to the authors.

PBF: performance based financing, DTP: diphtheria and tetanus toxoids and pertussis-containing vaccine, OPV: oral polio vaccine

available to finance service delivery. Evidently, these schemes are not solely targeted at raising immunization coverage, and the objective of the studies was to assess the effect on a wide range of maternal and child health services.

Only the study in Cameroon found an increase in vaccine uptake (167). This study also had an arm that received financing with additional resources not linked to performance which showed similar positive results as the PBF arm (167). This led the authors to conclude that additional funding rather than the incentives could be driving improvements (167). A trial in Afghanistan found minimal effects on any maternal and child health indicators (168). The researchers explain that this could have been due to communication issues because health workers did not understand the incentives and also inattention to demand-side factors (168). In the trial in the Republic of Congo, it is suggested that vaccine supply issues hindered coverage improvement (169).

Home visits

Three studies assessed home visits with a broad range of objectives: to remind and recall, offer support and guidance, follow-up on missed opportunities, as well as surveillance and the collection of data (171,175,177). In Ghana, Brugha and Kevany trained non-health workers to carry out home visits and saw an increase in immunization coverage, but they also point out that their strategy requires a high level of support, training, and supervision and may not be cost-effective (171). In Turkey, Gokcay et al. compared the performance of midwives with health volunteers who received three weeks of training and found no difference in maternal and child health outcomes (175). Additionally, they observed that the health volunteers were more highly motivated than the midwives (175). In the final study by More et al. (177), home visits were part of a multifaceted approach to reach the urban poor.

Outreach services

There were four trials that assessed the impact of providing outreach to populations with limited access to health care services (163,172,177,178). Banaree et al. held monthly immunization outreach camps for disadvantaged populations in rural India (163). Cristia et al. also focused on rural areas in Guatemala and examined the impact of contracting-out primary health care services to non-governmental organisations (172). The services were carried out by mobile medical teams comprising a physician or a nurse and a health assistant and visited communities at least monthly. Both interventions improved vaccination rates (172).

The setting for the other two studies was urban slums in India (177,178). More et al. allocated intervention communities to have a resource centre that carried out activities addressing maternal and child health, family planning, and violence against women and children (177). Outreach immunization camps were organised, and information about immunization was provided during home visits. There was an improvement in various maternal and child health indicators but

not immunization uptake (177). Sengupta et al., based on discussions at community meetings, designed a strategy of outreach immunization clinics with the provision of community guardians (178). Community guardians are adults nominated to be present to provide consent and post-immunization surveillance in the parent's absence. The intervention had a positive impact on full vaccination rates (178)

Integration with other services

There were two studies that observed the effects of integrating immunization services with other services (170,173). In Kenya, Briere et al. assessed the impact of integrating with hygiene interventions; water treatment and correct handwashing increased in the intervention group but not in the control group, whereas vaccination coverage increased in both groups (170). The authors conclude that distributing hygiene kits during routine immunization positively impacted household hygiene without negatively impacting vaccine coverage (170). In Mali, Dicko et al. saw a positive impact on immunization rates upon integrating malaria preventive treatment (173). Although they comment that the effect may have been due to increased supervision of the health workers.

Vaccine vials with fewer doses

In Zambia, Krudwig et al. observed that switching from conventional 10-dose measles-containing vaccine vials to 5-dose vials improved coverage (176). Immunization providers were satisfied as they were less worried about wastage and ensuring stock availability (176).

Training and supervision of providers

Two trials assessed training and supervision of immunization providers (141,174). In Nigeria, Brown et al. found that a two-day refresher training for primary health care workers who carry out immunization (nurses, midwives, community health officers, and community health extension workers) marginally increased coverage (141). The results of a study by Djibuti et al. in Georgia on the effectiveness of a range of supportive supervision measures for immunization providers only showed borderline greater coverage increase in the intervention group for one of the three vaccines being measured (174). The intervention consisted of developing supervision guidelines, training of district immunization managers in supportive supervision, monitoring and evaluation of performance, and funding for district immunization managers to carry out supervision.

Lay health workers

Lay health workers – health workers with no formal professional training – played a role in 10 studies: They carried out home visits in six studies (155,159,160,171,175,177), were

responsible for reminding recipients about vaccine appointments in two studies (142,144), were trained to carry out community discussions about immunization in one study (150), and led a health program for pregnant women in one study (151). Half of the trials studied CHWs who already existed as part of the local health system (142,144,151,155,160), and the other half recruited lay-people and trained them specifically to carry out interventions (150,159,171,175,177). In the trials with lay health workers performing home visits, two showed coverage improvement (160,171), one proved that CHWs were not inferior to midwives (175), and there was no difference in vaccination rates between groups in three trials (155,159,177). In the remaining four studies, lay health worker interventions improved vaccination coverage (142,144,150,151).

5 Discussion

Determinants of vaccine coverage in the Philippines

The current most important inhibitors to universal childhood immunization coverage in the Philippines are to do with supply and community access. National vaccine stock-outs are a critical bottleneck to high immunization uptake. This problem is partly due to the increasing number of recommended childhood vaccines and the global issues of rising vaccine prices and opacity surrounding the vaccine market. However, procurement failures are also said to be due to unsuccessful tender bidding. There is room for improvement in vaccine supply chain management as well. An adequate supply of vaccines is a prerequisite for a successful vaccination program. When supply-side constraints exist, interventions to improve access or increase demand cannot be effective.

Filipinos residing in rural and remote areas, conflict-affected regions, and urban slums face barriers to service utilisation. This is reflected in the large number of zero-dose children in the country. Of course, access is not the only challenge for these people. For instance, in rural areas, lack of workforce is also a factor. Conflict has direct negative impacts on facility readiness. Socioeconomic characteristics, such as poverty and low education levels, could also be playing a part in lowering intent to vaccinate. However, access is a common issue across many populations in the Philippines with low coverage rates. Equity in immunization coverage is also an important consideration, and therefore access needs to be addressed.

A focus on supply and access is also in line with the Philippine health system's broader goals. Building a resilient health system that can withstand natural disasters and the effects of climate change is a pressing mission for the government. Successfully implementing the national health insurance scheme and achieving UHC is another principal target.

Vaccine coverage determinants are interconnected. Although I have attempted to rank the importance of determinants, I would like to emphasise that factors interact with and influence each other in complex ways. I also want to stress that my conclusions are from an analysis of routine childhood immunization coverage at the national level. At the local level, each situation is unique, and it may be the case that different elements play a more influential role in specific settings.

Vaccine hesitancy

In the wake of the dengue vaccine controversy, attitudes towards vaccines are a large concern in the Philippines. Fear and mistrust of vaccines and the national immunization program were particularly high in the immediate aftermath of the Dengvaxia crisis. Vaccine hesitancy is certainly present in the Philippines; demand for the dengue vaccine, new vaccines such as HPV and the COVID-19 vaccine, and school-based immunization campaigns are more likely to continue to be affected. Fortunately, there are signs that confidence in routine childhood vaccines is rebounding. Vaccine coverage was languishing from before the dengue vaccine scare;

therefore, I think that vaccine availability and access failures, not lack of demand due to vaccine hesitancy, are the principle drivers of low coverage. A vital lesson of the dengue vaccine scare is the need for better communication among vaccine stakeholders.

The impact of COVID-19 on routine childhood immunization

COVID-19 has disrupted routine immunization services worldwide (179). The Philippines is no exception, and the pandemic is turning out to be the latest of a series of blows to childhood routine immunization. The estimates of national vaccine coverage in 2020 paint a bleak picture and show the declining trend continuing (14). Extra efforts will be necessary to identify missed children and implement catch-up immunizations; these activities will need to be integrated with ongoing efforts to raise vaccine coverage (180).

Perhaps a silver lining of the COVID-19 pandemic is that it has shed light on the global vaccine equity debate. Topics such as vaccine nationalism and global inequality in the distribution of COVID-19 vaccines have been taken up by mainstream media and debated outside of public health and global health disciplines. The market entry of developing country manufacturers is thought to be crucial in achieving sustainable vaccine pricing, and issues such as intellectual property and technology transfer need to be dealt with (181). There is hope that the COVID-19 pandemic will speed this process.

Interventions to improve vaccine coverage in LMICs

The evidence from the studies in my rapid review suggests that SMS text reminders, call reminders, community-based health education, outreach services, home visits, lay health worker interventions, and incentives in combination with other interventions can improve coverage. Other interventions had limited studies or mixed results and require further investigation. In the following section, I will discuss the interventions that are relevant in the Philippine context as well as a few other topics of interest.

Interventions targeting vaccine supply

Some of the studies in my rapid review highlight the significance of an adequate vaccine supply. For example, a study assessing PBF saw coverage reductions in both the intervention and control groups, supposedly due to vaccine supply issues (169). In another study on SMS text reminders, vaccine shortages forced the researchers to change the outcome measure to whether participants turned up for immunization visits, although the shots were not actually always available (129).

Stock-outs are an urgent problem in the Philippines, and supply chain management could also be improved. Nonetheless, I found no studies that looked at interventions targeting these problems. This may be because such interventions – for instance, changes in national

procurement processes – are difficult to evaluate with experimental trials. A previous systematic review on strategies to increase routine immunization coverage in LMICs has pointed out that grey literature tends to focus more on the national than the subnational level (46). Another reason could be that studies assessing changes to supply chains and procurement processes are more likely to have outcomes such as cost or product availability as outcomes. Hence, a search that included observational trials and program evaluations, grey literature, and outcomes other than vaccine coverage might be able to find literature with hints for solving these issues.

Interventions targeting the workforce

I did not find evidence that interventions targeting the workforce were effective in raising immunization coverage. PBF was designed to work partly by raising health care worker morale through incentives. Only one of the four studies about PBF in my rapid review found an increase in vaccine coverage (167). A systematic review on PBF in LMICs (182) and another on financial arrangements for health systems in low-income countries (183) have only found weak and uncertain evidence about its effectiveness in improving maternal and child care. PBF has been actively promoted by the World Bank and donors over the previous decade but is becoming divisive with accusations of it being a donor-driven solution and claims that it can damage health systems in the long run (184).

The trials on training and supervision in my review also did not show convincing benefits for vaccine uptake (141,174). The study on training had three intervention arms: call reminders, training, and both interventions (141). The justification for the study is evidence from previous studies that reminder systems, alone or in combination with other interventions, can be effective in improving coverage; however, no particular reason is given for why training was chosen (141). It may simply be that the training was not effective – for example, the content or the way it was carried out needs to be improved – but it could be that the workforce’s skills and knowledge were not the determining factors inhibiting vaccine uptake.

In the study on supportive supervision, lack of management and supervision capability at peripheral levels was identified as an important factor influencing low immunization coverage rates in Georgia (174). This study also looked at other indicators such as refusals and vaccine wastage rates, as well as the motivation and satisfaction of managers and health care providers. Although vaccine coverage only showed slight improvement, overall it mainly found positive impacts across the measured outcomes (174). Moreover, perhaps training and supervision should be regarded more as activities that strengthen the foundation of the routine immunization system but do not improve coverage in the short-term, as explained by the GRISP framework.

Reminder and recall interventions

My review builds on a systematic review by Oyo-lta et al. about interventions for improving childhood immunization coverage in LMICs (36). Regarding intervention types, there

was a considerable increase in studies evaluating reminder and recall interventions. Of the 14 studies in the review by Oyo-Ita et al., only two included interventions to remind caregivers of upcoming vaccine appointments; in my review, the number was 20 out of 51 studies. They have become by far the most studied type of intervention. I think there are three reasons for this: (i) they have been proven to be effective in high-income countries (49), (ii) it is a straightforward intervention that is well-suited for experimental trials, and (iii) because digital technology has a promising role to play in reminder interventions.

A systematic review on patient reminder and recall interventions to improve immunization rates by Jacobson Vann et al. found that they were effective for children, adolescents, and adults, in many types of medical and health settings (49). Only three of the 75 studies included in this review were conducted in LMICs (49). My results tend to agree with this review, but I found that some types of reminders were not effective. SMS text reminders, the most extensively studied, were effective in most cases (131–134,136–138,140). Call reminders also had mostly positive impacts (132,140–142). A couple of trials tried automated call reminders; in one trial, they were effective in combination with SMS texts (140), and in another trial, the system failed (143). In a small number of studies, redesigning immunisation cards increased coverage (146,147), but stickers (131,148), bracelets (145), and pendants (143) were not effective reminders.

In the trials in my review, SMS text reminders also appeared relatively easy to implement. Many of the trials used existing systems or platforms to send the SMS texts (130,133,135–137), and few reported technical complications. This is an important finding in LMICs where telecommunication infrastructure can be less well-developed. I speculate that reminders could be even more important when opportunities for vaccination are limited, for example, in a remote area where there are only periodic outreach services. On the other hand, low mobile phone use among the poor and lack of connectivity in remote areas might inhibit the usage of digital reminders in situations where they could be crucial. Literacy levels can also be a concern. Call reminders also have a positive impact but will be more resource-intensive.

Home visits by CHWs

In a review on improving routine immunization programs in developing countries published in 2008, Ryman et al. found that home visits by CHWs to educate, motivate caregivers to utilise immunisation services, and track target populations could be very successful (47). Maybe because it is already a widely-implemented intervention that is acknowledged to be effective, only a few trials in my review evaluated this approach. There were a few more studies that looked at certain aspects of home visits by CHWs, for example: using targeted pictorial messages in low literacy settings (160), comparing framing information as a gain or a loss (161), and comparing offering tailored information to generic information (162).

Although home visits by CHW may be effective, considering the advance of digital

telecommunication technology as well as the expanding roles and responsibilities of CHWs, they may no longer be the most efficient and cost-effective intervention. Then again, in settings with limited infrastructure or highly mobile populations, home visits may be the only means to contact caregivers and track children.

Interventions to increase coverage in urban slums

Crocker-Buque et al. conducted a systematic review on interventions to increase vaccine coverage in urban slums in LMICs (120). They concluded that multi-component interventions were effective, especially if they have been designed with community involvement; outreach was effective; and SMS text reminders, community-based health education, and financial incentives warranted further evaluation (120). The multi-component interventions are intensive and include approaches such as extended service hours, provider training, additional staff, task-shifting, screening tools, geographic monitoring, outreach, and community support groups (120). They included a wide range of study designs, and most of the identified studies about multi-component interventions are observational studies and uncontrolled before-after studies (120).

My review included seven trials targeting the urban poor and they evaluated a multi-component intervention (177), outreach (178), SMS text reminders (133,137), health education through home visits (160), and health education through a mobile device (158). Only the multi-component intervention did not report a positive impact on vaccine coverage (177), which may seem to go against the results of Crocker-Buque et al. However, the study on a multi-component intervention in my review carried out outreach and home visits as part of a larger project to improve the health and well-being of women and children in informal settlements of Mumbai (177). It is not an intervention that was specifically designed to increase vaccine coverage and has a different character to the multi-component interventions in the review by Crocker-Buque et al. Actually, the study on outreach may be more comparable, as it was designed and implemented based on opinions from the community (178).

The importance of community involvement

Previous studies and reviews (42,47,120) have pointed out how community involvement is a driver for improved immunization coverage. The results from my review support this idea. I found increased vaccine uptake in almost all studies about community-based health education; two of the six studies involved lay health workers (150,151), two involved traditional and religious leaders (149,152), and one had school students promoting immunization (154). I also found that the studies involving CHWs or lay health workers had mostly positive impacts on vaccination coverage (142,144,150,151,160,171,175). There was also a study on outreach in urban slums that involved key stakeholders from the planning phase and resulted in coverage improvement (178). Engaging and establishing partnerships with the community appears to be a key element for the success of interventions.

The promise of digital technology

There is growing interest in digitalisation's role in strengthening health systems (185), and the increase of studies looking at digital interventions in my review reflects this. There were 17 in total, and they were all published after 2015. The majority were SMS text and call reminder interventions, and there were a few trials that also offered incentives delivered through mobile phones in addition to reminders (130,135,142). Other than the studies on interventions to remind and recall, there were studies evaluating health education through mobile devices (156,158), and a study that assessed an app that enabled village doctors to keep records and track children (139).

There are many possibilities to connect digital systems and improve the efficiency and quality of immunization services. Software to support vaccine providers could become a platform for continued education, training, and supervision. It could be linked with a system to remind caregivers about appointments, provide them with health information, and offer incentives. The data collected could be utilised for vaccination coverage monitoring and could be integrated into supply management systems that facilitate sufficient procurement of vaccine doses. More studies are required to explore the potential of digital technology and evaluate its usefulness in vaccination programs.

Studies from the Philippines

There were no studies set in the Philippines in my review. In previous reviews (45–47), I found two studies conducted in the Philippines. One was included in a review of the grey literature by Batt et al. (46) and was about the supervision of immunization providers. It was in a UNICEF report published in 1990, and I could not get hold of it. Another was about a national mass media campaign, utilizing television and the radio, carried out in 1990 (186). The campaign focused on measles because it is the most common VPD and its symptoms are easily recognisable. Wednesdays were promoted as “vaccination days” and mothers were encouraged to bring their children to health facilities to receive free vaccinations. A pre- and post-survey found the proportion of fully vaccinated children aged 12-23 months increased from 54% to 65% (186).

Generalisability of results

I classified the interventions by type in an attempt to determine which were effective. However, I found that the contents of interventions of the same type could be considerably varied. The outcomes used to measure coverage were also different across studies. Furthermore, vaccine uptake is influenced by multiple factors, and barriers are context-specific. Some studies tested interventions that were not linked to identified needs in the study settings. Baseline vaccination rates were very different, plus many studies did not provide an analysis of the likely reasons for sub-optimal coverage or information about the health system and current EPI

operations. Therefore, it is difficult to determine whether interventions could be successfully adopted in other settings.

Strengths and Limitations

My study provides a comprehensive overview of the determinants of vaccine coverage in the Philippines. Previous appraisals of the routine immunization system in the Philippines have mainly been from the health system side (7,54,77), and many papers examine the dengue vaccine controversy and its effect on vaccine confidence (19,21,22,86). I was able to illustrate that there are multiple factors on both the supply and demand sides that interact to influence vaccination uptake. My study also identifies the nature and scope of the most recent research evidence from experimental trials on interventions to improve childhood vaccine coverage in LMICs.

There are two main limitations to my literature review of vaccine coverage determinants. Firstly, due to resource constraints, I relied solely on literature available through internet search engines. Secondly, as English is the only one of the official Philippine languages I understand, my search was conducted only in English. I was not able to find detailed information on certain topics such as the NIC, the contribution of BHWs to routine immunization, or the REB/REP strategy. I had to interpret the lack of information as indication that there was not much substance behind these initiatives. Consulting experts on immunization programs or the health system in the Philippines could have helped me uncover more relevant literature. Interviews with national and local health officials might have given me a better understanding of issues that are not well documented.

For my rapid review of the literature on interventions to increase coverage in LMICs, I relied heavily on the search methods and the results of a previous systematic review (36) to formulate my search strategy. I only searched Cochrane CENTRAL and did not conduct an exhaustive search of all accessible literature databases. I may have missed out on a number of trials, especially those published in grey literature. And again, I only searched the English literature. I could be overlooking the body of Spanish, French, Arabic, and Chinese literature on research in Latin America, Africa, the Middle East, and China. Another limitation is that I did not have the resources to assess the quality of the studies in my review. As a consequence, there is the possibility that I have included several low quality studies.

6 Conclusions and Recommendations

The main challenges faced by the Philippines in improving routine childhood immunization coverage are guaranteeing a sufficient supply of vaccines and providing access to immunization services for all. A combination of strategies to secure the foundations of the system and interventions to accelerate routine immunization activities, as outlined in the GRISP framework, will be required to improve coverage.

Recommendations for national policy-makers

Strengthen national leadership and governance

Routine childhood immunization rates in the Philippines are declining and strong leadership and governance from the DOH are needed to turn the tide and achieve high coverage. Three topics that urgently need to be addressed are (i) national vaccine procurement procedures, (ii) how to prioritise equitable access for every child, and (iii) recovery of routine immunization programs from the disruption of COVID-19. Establishment of a NITAG, or reforming the current NIC so that it can function competently as a NITAG, is a vital step towards better governance and increased transparency.

Increase support for LGUs in managing immunization programs

LGUs will be responsible for implementing the services and activities that improve access and ensure that vaccines reach every child in the Philippines. The management capacity of local health officials will be critical and the DOH needs to increase efforts to train and technically support them. A strategic focus should be on LGUs with rural and remote areas, conflict-affected regions, and urban slums. A platform for sharing best practices amongst LGUs could be beneficial to further understanding about effective interventions in the Philippine context. Although LGUs are responsible for covering the operational expenses for service delivery at local facilities, some LGUs with large under-vaccinated populations may require additional financial support.

Recommendations for local health officials and program managers

Implement targeted interventions that address the needs of communities

Interventions should be context-specific and tailored to the needs of the targeted communities. The initial step in planning interventions at the local level will be to analyse the barriers to vaccine uptake and consider which interventions could address those causes. What works best in ARMM – a rural, predominantly Muslim, conflict-affected area where internet penetration is not very high – will be different from what works best in the urban slums of Manila. Even in the absence of strong evidence, an intervention that will help overcome an identified obstacle should be considered.

Involve the community in routine immunization programs

Interventions are more likely to succeed if the community is engaged in their planning and delivery. As BHWs function at the interface between communities and the health system, they can serve as a critical link. The involvement of religious and traditional leaders can also be important; efforts should be made to obtain, if not their active participation, at least their support for immunization programs and activities. Additionally, considering the hesitancy that could be present in communities after the Dengvaxia scare, it is vital to have clear messaging, well-defined channels of communication, and open dialogue.

Implement evidence-based interventions to increase coverage

There is a small but growing body of evidence on interventions to increase vaccine coverage in LMICs. Reminders can increase vaccine uptake. Particularly SMS text reminders appear to be effective and, in addition, relatively simple to implement. Overall, Filipinos have high mobile phone use and high literacy levels, but each situation will have to be independently assessed. If deemed feasible, SMS text reminders should be considered. When digital reminders are difficult to implement, home visits may have to be carried out to track children, contact caregivers, remind them of upcoming appointments, and recall those that missed appointments. Small incentives in combination with other interventions have the potential to boost uptake.

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Appendix 1 Types of interventions and how they work

This table was originally presented in a systematic review by Oyo-Ita et al. (36) and I referred to a paper about the development of a taxonomy of communication interventions to improve coverage (37) to make some adaptations.

Target	Intervention	Purpose	
Recipients	Inform and educate	<ul style="list-style-type: none"> • Face to face interactions • Postcards, letters or email • Phone calls or SMS • Device or tool • Audio visual/performance • Printed material • Web-based • Media campaign • Community event 	To improve understanding on vaccination; its relevance; benefits and risks; where, when, and how to receive them; and who should receive them
	Remind and recall	<ul style="list-style-type: none"> • Face to face interactions • Postcards, letters or email • Phone calls or SMS • Device or tool 	To remind those who are overdue for vaccination in order to reduce drop-out rate
	Teach skills	<ul style="list-style-type: none"> • Parenting skills programmes • Peer to peer information sharing • Training in how to communicate/provide education to others 	To provide people with the ability to operationalise knowledge through the adoption of practical skills
	Support	<ul style="list-style-type: none"> • Face to face interactions • Phone contact • Web-based 	To provide assistance or advice for consumers
	Interventions to enhance community ownership	<ul style="list-style-type: none"> • Community coalition • Programme delivery • Community input • Partnership building 	To increase demand for vaccination, ensure sustainability, and/or build trust in vaccination and vaccination services
	<ul style="list-style-type: none"> • Incentives • cash transfers 		To reward service uptake; to cover out-of-pocket cost
Providers	<ul style="list-style-type: none"> • Training 		To improve knowledge on vaccination, to improve skills, to improve attitudes to clients, to reduce missed opportunities for vaccination
	<ul style="list-style-type: none"> • Audit and feedback 		To ensure quality and client satisfaction with services
	<ul style="list-style-type: none"> • Supportive supervision 		To ensure quality and maintain standards, to reduce missed opportunities for vaccination
	<ul style="list-style-type: none"> • Performance based financing • Incentives 		To boost morale and enhance performance
Health system	Infrastructural development	<ul style="list-style-type: none"> • Provision of health facilities, • Provision of road to improve access to health facilities 	To ensure access to services
	<ul style="list-style-type: none"> • Logistic support 		To improve service quality and so improve utilisation to ensure availability of services
	<ul style="list-style-type: none"> • Outreach • Home visits to remind parents about vaccination and identify unimmunized children for immunization • Integration of vaccination with other services • Guidelines and protocols to ensure quality of services • Improved resources to ensure availability of services 		To improve access to services
	Technical support	<ul style="list-style-type: none"> • Digital apps • Changes in vaccine vials, syringes 	

Appendix 2 The two perspectives of “routine immunization”

Global Routine Immunization Strategies and Practices (GRISP): a companion document to the Global Vaccine Action Plan (GVAP) p.12 (38)

Securing the Foundation: strengthen routine immunization systems	Reaching towards Universal Immunization Coverage: accelerate routine immunization activities
<p>“Routine immunization” refers to the part of the health system that facilitates vaccination service delivery to all those eligible.</p> <p>The term encompasses system components such as:</p> <ul style="list-style-type: none"> ◆ programme planning, management and financing; ◆ service implementation with adequate human resources, logistic support through relevant delivery strategies and monitoring; ◆ data recording and reporting; ◆ programme communication; and ◆ vaccine supply and management with quality assurance. <p>It is the foundation on which the entire programme is built and is a part of the overall health system of a country.</p> <p>Many components of the immunization system are not unique to the immunization programme but are common to all programmes and components of the health system.</p> <p>Within GRISP, “Securing the Foundation” is reflected in strategies and activities, such as programme leadership, human resource capacity building, vaccine availability and quality, political commitment, programme planning and financing, policy guidance and monitoring and surveillance.</p>	<p>“Routine immunization” may also describe the process to regularly deliver vaccines according to the national vaccination schedule, and specific activities are designed to boost routine immunization coverage rapidly, to reach stated coverage or disease control goals. These may often lack long-term sustainability.</p> <p>Routine immunization coverage is the percentage of the target group that is provided with the appropriate number of doses of a specific vaccine according to their age, and is a measure of the ability to reach the target population.</p> <p>In addition to disease-specific activities and special projects such as the introduction of a new vaccine, a country’s routine immunization programme should implement tailored activities to increase routine immunization coverage where it is lagging.</p> <p>Within GRISP, “Reaching towards Universal Immunization Coverage” is reflected in strategies and activities such as detecting and reaching marginalized and partially served populations, improving coverage equity, creating synergy with accelerated disease control activities, creating demand for vaccination, mobilizing and communicating for vaccination, and addressing vaccine hesitancy.</p>

Appendix 3 Search keywords for determinants of vaccination coverage

General keywords:

Philippines, vaccine coverage, immunization coverage, Expanded Programme on Immunization, EPI, routine immunization, childhood immunization, child immunization, vaccine-preventable diseases, VPD, COVID-19

Determinant in framework	Keyword
Supply	vaccine supply, vaccine stock-outs, vaccine shortages, Pentavalent vaccine, cold chain, supply chain, Effective Vaccine Management, EVM
Workforce	health workforce, health care workforce, health workers, health care workers, human resources for health, HRH, public health nurse, community health workers, barangay health workers, health worker migration
Facility Readiness	immunization financing, sin tax, Sin Tax Reform, National Immunization Technical Advisory Group, NITAG, National Immunization Committee, NIC, decentralisation, devolution, typhoon
Intent to Vaccinate	vaccine hesitancy, vaccine confidence, Theory of Planned Behaviour, TPB
Attitudes	Dengue vaccine, Dengvaxia, internet use, social media, mobile phone use
Perceived Norms	perceived norms, subjective norms, tetanus vaccine
Perceived Control	perceived control
Community Access	access, community access, zero-dose children, rural, remote, conflict-affected, urbanisation, slums, urban slums, urban poor, Reaching Every Purok, REP

Appendix 4 Characteristics of previous systematic reviews

Author, year	Objectives	Databases searched and/or other search methods	Number of studies	Study designs included	Conclusions
Pegurri, 2005 (45)	To describe the available literature on effects and costs of interventions to expand the coverage of immunization programs in developing countries	Medline; Popline; BIDS; CAB Abstracts; Web of Science; PubMed; EconLit; HEED; The Cochrane Library; and the WHO regional databases (LILACS, IMSEAR, IMEMR and AIM)	60 (52 on effectiveness)	Majority of studies used an ecological design and 3 were RCTs	Difficult to reach firm conclusion given the quality and paucity of the papers. Almost all interventions had a positive impact on coverage. The strategies with the highest percentage increases in full coverage were CHWs and channelling.
Batt, 2005 (46)	Companion review to Pegurri, 2005 To review grey literature on the cost and effectiveness of strategies to improve immunization coverage. Compare the quality, quantity and nature of evidence in the grey literature and the published literature	System for Information on Grey Literature in Europe (SIGLE), Eldis, Health Technology Assessment (HTA) at the Centre for Review and Dissemination at the University of York, Popline, CAB abstracts and regional WHO databases Hand searches in institutional documentation centres within WHO, UNICEF, PAHO, USAID Interviews with 28 international experts A three-way search of the Internet including free text searches in Google using the same keywords and "similar pages"; a search of conference proceedings; a search of web pages of international organizations, bilateral agencies, NGOs, consultancy firms and universities	34 (24 on effectiveness)	All 24 effectiveness studies adopted an ecological design. 13 used a single time series, 10 a multiple time series, and 1 had a multi-group design in one time period.	The evidence in the grey literature was more recent and tended to focus on national rather than subnational levels. Most interventions increased the coverage of fully vaccinated children. The grey literature suggested campaigns to educate health workers or mass campaigns as well as alternative models for providers or payers would be effective.
Ryman, 2011 (47)	To review strategies that may be used at the community or facility level that have been shown to strengthen routine immunization programs.	On-line library journal databases Requested information from 35 websites including WHO regional databases, dissertation, theses and grey literature database websites Contacted 31 experts in the field	25 (23 trials) All from published literature	6 observational studies, 8 trials with evaluation before and after, and 9 trials with comparison groups	It was startling to see how few papers were identified and in particular how few were of strong scientific quality. Further well-designed and well-conducted scientific research is warranted.
Oyo-Ita, 2016 (36)	To evaluate the effectiveness of intervention strategies to boost and sustain high childhood immunization coverage in LMICs.	Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register, MEDLINE In-Process and Other Non-Indexed Citations, MEDLINE Daily, MEDLINE, OvidSP, EbscoHost, Embase, LILACS, VHL, ProQuest, ICTRP, ClinicalTrials.gov Citation search for all included studies in Science Citation Index and Social Sciences Citation Index, Emerging Sources Citation Index	14	10 cluster RCTs and 4 individual RCTs	Most of the evidence was of low certainty. There is a need for further well-conducted RCTs to assess the effects of interventions for improving childhood immunization coverage in LMICs.

Appendix 5 Cochrane CENTRAL search strategy

Search conducted on November 11, 2021

ID	Search	Hits
#1	MeSH descriptor: [Immunity] this term only	309
#2	MeSH descriptor: [Immunization Schedule] this term only	1139
#3	MeSH descriptor: [Immunization, Secondary] this term only	911
#4	MeSH descriptor: [Immunotherapy, Active] this term only	98
#5	MeSH descriptor: [Mass Vaccination] this term only	39
#6	MeSH descriptor: [Immunization Programs] this term only	194
#7	MeSH descriptor: [Vaccination] this term only	2648
#8	#1 or #2 or #3 or #4 or #5 or #6 or #7	4460
#9	MeSH descriptor: [Child] explode all trees	58991
#10	MeSH descriptor: [Infant] explode all trees	33690
#11	MeSH descriptor: [Mothers] this term only	2006
#12	MeSH descriptor: [Women] this term only	237
#13	MeSH descriptor: [Pregnant Women] this term only	390
#14	#9 or #10 or #11 or #12 or #13	78646
#15	#8 and #14	2191
#16	(immunization or immunisation or vaccination) next (program* or rate* or coverage or adher*):ti	306
#17	(vaccinat* or revaccinat* or immunization or immunisation) near/3 (child* or infant* or newborn* or neonat* or baby or babies or kid or kids or toddler* or woman or women or mother or mothers):ti,ab,kw	3408
#18	#15 or #16 or #17	4963
#19	(Africa or Asia or Caribbean or "West Indies" or "South America" or "Latin America" or "Central America"):ti,ab,kw	13341
#20	(Afghanistan or Albania or Algeria or Angola or Antigua or Barbuda or Argentina or Armenia or Armenian or Aruba or Azerbaijan or Bahrain or Bangladesh or Barbados or Benin or Byelarus or Byelorussian or Belarus or Belorussian or Belorussia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brazil or Brasil or Bulgaria or "Burkina Faso" or "Burkina Fasso" or "Upper Volta" or Burundi or Urundi or Cambodia or "Khmer Republic" or Kampuchea or Cameroon or Cameroons or Cameron or Camerons or "Cape Verde" or "Central African Republic" or Chad or Chile or China or Colombia or Comoros or "Comoro Islands" or Comores or Mayotte or Congo or Zaire or "Costa Rica" or "Cote d'Ivoire" or "Ivory Coast" or Croatia or Cuba or Cyprus or Czechoslovakia or "Czech Republic" or Slovakia or "Slovak Republic"):ti,ab,kw	30865
#21	(Djibouti or "French Somaliland" or Dominica or "Dominican Republic" or "East Timor" or "East Timur" or "Timor Leste" or Ecuador or Egypt or "United Arab Republic" or "El Salvador" or Eritrea	39477

	or Estonia or Ethiopia or Fiji or Gabon or "Gabonese Republic" or Gambia or Gaza or Georgia or Georgian or Ghana or "Gold Coast" or Greece or Grenada or Guatemala or Guinea or Guam or Guiana or Guyana or Haiti or Honduras or Hungary or India or Maldives or Indonesia or Iran or Iraq or "Isle of Man" or Jamaica or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzstan or Kirghizia or "Kyrgyz Republic" or Kirghiz or Kirgizstan or "Lao PDR" or Laos or Latvia or Lebanon or Lesotho or Basutoland or Liberia or Libya or Lithuania):ti,ab,kw	
#22	(Macedonia or "North Macedonia" or Madagascar or "Malagasy Republic" or Malaysia or Malaya or Malay or Sabah or Sarawak or Malawi or Nyasaland or Mali or Malta or "Marshall Islands" or Mauritania or Mauritius or "Agalega Islands" or Mexico or Micronesia or "Middle East" or Moldova or Moldavia or Moldovan or Mongolia or Montenegro or Morocco or Ifni or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or "Netherlands Antilles" or "New Caledonia" or Nicaragua or Niger or Nigeria or "Northern Mariana Islands" or Oman or Muscat or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or Poland or Portugal or "Puerto Rico"):ti,ab,kw	16328
#23	(Romania or Rumania or Roumania or Russia or Russian or Rwanda or Ruanda or "Saint Kitts" or "St Kitts" or Nevis or "Saint Lucia" or "St Lucia" or "Saint Vincent" or "St Vincent" or Grenadines or Samoa or "Samoan Islands" or "Navigator Island" or "Navigator Islands" or "Sao Tome" or "Saudi Arabia" or Senegal or Serbia or Montenegro or Seychelles or "Sierra Leone" or Slovenia or "Sri Lanka" or Ceylon or "Solomon Islands" or Somalia or Sudan or Suriname or Surinam or Swaziland or Syria or Tajikistan or Tadjhikistan or Tadjikistan or Tadjhik or Tanzania or Thailand or Togo or "Togolese Republic" or Tonga or Trinidad or Tobago or Tunisia or Turkey or Turkmenistan or Turkmen or Uganda or Ukraine or Uruguay or USSR or "Soviet Union" or "Union of Soviet Socialist Republics" or Uzbekistan or Uzbek or Vanuatu or "New Hebrides" or Venezuela or Vietnam or "VietNam" or "West Bank" or Yemen or Yugoslavia or Zambia or Zimbabwe or Rhodesia):ti,ab,kw	17995
#24	(developing or less* next developed or "under developed" or underdeveloped or "middle income" or low* next income or underserved or "under served" or deprived or poor*) next (countr* or nation* or population* or world):ti,ab,kw	7824
#25	(developing or less* next developed or "under developed" or underdeveloped or "middle income" or low* next income) next (economy or economies):ti,ab,kw	19
#26	low* next (gdp or gnp or "gross domestic" or "gross national"):ti,ab,kw	49
#27	(low near/3 middle near/3 countr*):ti,ab,kw	1785
#28	(lmic or Imics or "third world" or "lami country" or "lami countries"):ti,ab,kw	582
#29	("transitional country" or "transitional countries"):ti,ab,kw	4
#30	#19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or # 27 or #28 or #29	239220
#31	#18 and #30 in Trials	2008
Filter to articles published after 2016		710 hits