The Value of Vaccines in Mitigating Antimicrobial Resistance in Bangladesh

GARP - Bangladesh Policy Brief

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ABBREVIATIONS AND ACRONYMS

AIDS	acquired immunodeficiency syndrome
AMR	antimicrobial resistance
AMU	antimicrobial use
ARI	acute respiratory infection
BCG	Bacillus Calmette Guérin
CAPTURA	Capturing Data on Antimicrobial Resistance Patterns and Trends in Use in Regions of Asia
CDC	Communicable Disease Control Division
DALYs	disability-adjusted life years
DDD	defined daily dose
EPI	Expanded Program on Immunization
FQNS	fluoroquinolone non-susceptibility
IPV	inactivated poliovirus vaccine
GARP	Global Antibiotic Resistance Partnership
GAVI	Global Alliance for Vaccines and Immunization
Hib	*Haemophilus influenzae* Type B
HIV	human immunodeficiency virus
IEDCR	Institute of Epidemiology, Disease Control, and Research
LMIC	low- and middle-income countries
MDR	multidrug-resistant
MR	measles-rubella
NAP	national action plan
NITAG	National Immunization Technical Advisory Group
NTD	neglected tropical diseases
OOP	out-of-pocket
OPV	oral polio vaccine
PCV	pneumococcal conjugate vaccine
PHC	primary health care
RR	rifampicin-resistant
RSV	respiratory syncytial virus
STI	sexually transmitted infection
TB	tuberculosis
TCV	typhoid conjugate vaccine
UNICEF	United Nations Children's Fund
WHO	World Health Organization

EXECUTIVE SUMMARY

In 2019, the World Health Organization (WHO) declared antimicrobial resistance (AMR) a global emergency. AMR was estimated to have caused 1.14 million deaths globally in 2021; this death toll is only expected to rise to 10 million in 2050. AMR could cause over 39 million deaths worldwide between 2025 and 2050, and the annual cost of treating antibiotic-resistant infections could reach US$159 billion, according to recent reports. World Bank projections from 2017 suggest that by 2030, AMR could result in gross domestic product losses of US$1–3.4 trillion. This substantial economic impact reflects both mortality and medical management costs for hard-to-treat infections.

In 2021, 96,878 deaths in Bangladesh were associated with, and 23,454 deaths were directly attributable to AMR. To contain its spread, the Directorate General of Health Services, under the Ministry of Health and Family Welfare, had developed a National Action Plan on Antimicrobial Resistance for 2021 – 2026, updating the earlier 2017 NAP, which aims to address surveillance gaps for human and animal health along with antimicrobial consumption trends, antimicrobial stewardship and infection control measures, and initiatives in community engagement.

Despite concerted efforts by numerous institutions along the One Health spectrum, significant barriers such as inadequate funding, insufficient evaluation, and monitoring continue to hinder the progress toward the goals set out in the national AMR plan. Furthermore, there appears to be limited awareness among policymakers, healthcare providers, and the general public regarding the substantial health and economic burden posed by drug-resistant infections.

Preventive interventions such as vaccines have significant potential in the containment of AMR, because they prevent infectious disease and subsequent antimicrobial therapy. The National Immunization Program's Expanded Programme (EPI) on Immunization has reduced the incidence of neonatal and childhood diseases for the past few decades through its wide-reaching vaccination programs. While the program provides a robust basic immunization schedule with substantial coverage, it would benefit immensely from including vaccines known to reduce AMR and antibiotic use, such as those against influenza, rotavirus, and continuing the typhoid vaccine.

Although global evidence shows that vaccines can reduce AMR, country-specific data are vital to inform Bangladesh's national immunization and antimicrobial policies and guide effective interventions. In this context, research is needed to quantify the role of vaccines in reducing the burden in Bangladesh. The Global Antibiotic Resistance Partnership (GARP)-Bangladesh technical working group has presented the following key policy recommendations to advance the use of vaccines in AMR mitigation:

1. Expand the use of licensed vaccines to maximize their impact on AMR mitigation.

2. Ensure and sustain universal uptake of childhood vaccines.

3. Update existing immunization guidelines.

4. Develop regulatory and policy mechanisms to accelerate approval and use of new vaccines that can reduce AMR.

5. Enhance the body of evidence on AMR and vaccines in Bangladesh by increasing the collection and analysis of AMR-relevant data in vaccine studies.

INTRODUCTION

Bangladesh has a population of over 170 million (World Bank 2023a), with 60 percent living in rural areas (World Bank 2023b). Life expectancy at birth was 74 years in 2022 (World Bank 2022a), and the mortality rate for children under 5 is 29 per 1,000 live births (World Bank 2022b). Despite 98 percent of the total population having access to basic drinking water services (World Bank 2022c), only 59 percent have access to safely managed drinking water services (World Bank 2022d). 61.73 percent has access to basic handwashing facilities, including soap and water (World Bank 2022g). Similarly, while 59 percent of the population uses basic sanitation services, only 31 percent have access to safely managed sanitation services (World Bank 2022e; World Bank 2022f).

Antibiotic misuse and overuse are major drivers of antimicrobial resistance (AMR). This misuse is evident in the common practice of prescribing antibiotics for infections that do not respond to them, such as viral respiratory illnesses (Kasse et al. 2024). Consumers often purchase unprescribed antibiotics from pharmacies and unqualified vendors to avoid hospital waiting times and out-of-pocket (OOP) expenditures related to medical consultations (Gashaw et al. 2025; Ahsan et al., 2025). One survey found that half of the antibiotics dispensed in the country were without a prescription (Islam et al. 2022). Additionally, due to time constraints, costs, and availability, physicians may resort to prescribing broad-spectrum or preventive antimicrobials instead of using diagnostics to identify the cause of infections (Sumon et al. 2024).

In Bangladesh, just over a third of all antibiotics used are from the WHO "Access" group, which are recommended for first-line treatment, falling far below the target proportion (Islam et al. 2022; Sharland et al. 2022). Antimicrobials are also used inappropriately as prophylactics to facilitate growth in livestock (Amin et al. 2020; Hosain et al. 2021). Enacting legislative measures to monitor and control the abuse of antimicrobials has proven challenging due to poor awareness about antibiotics and AMR, prescribing practices, and inadequate vigilance (Hoque et al. 2020; Nizame et al. 2021; Islam 2023). Addressing the misuse of antibiotics is essential, but so are preventive strategies such as vaccination which play a crucial role in combating AMR by reducing the need for antibiotics (Hasso-Agopsowicz et al. 2024).

With inappropriate consumption of antibiotics, and limited access to safely managed water, sanitation, and hygiene (WASH) facilities, Bangladesh remains vulnerable to the growing threat of AMR. In 2021, 96,878 deaths in Bangladesh were associated with AMR and 23,454 of these deaths were directly attributable to it (IHME 2021).

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Globally, AMR has emerged as a critical public health threat that challenges institutions and government policies, especially in low- and middle-income countries (LMICs). In 2019, bacterial AMR was directly responsible for an estimated 1.27 million deaths around the world, with projections suggesting that this figure could rise to 10 million annually by 2050 if immediate action is not taken (WHO 2019b; EClinicalMedicine 2021). However, in 2021, the global death toll due to AMR was reported to be 1.14 million (IHME, 2024). According to a recent estimate by the EcoAMR Series, if action is not taken, AMR could cause over 39 million deaths worldwide between 2025 and 2050, and the annual cost of treating antibiotic-resistant infections could reach US$159 billion (World Organisation for Animal Health and World Bank 2024). The economic burden is equally alarming, as AMR could result in global losses of up to US$1 to 3.4 trillion by 2030 and push up to 24 million people into extreme poverty (Costanzo and Roviello 2023). AMR disproportionately impacts LMICs and undermines global health systems (Jonas et al. 2017).

In recognition of this growing crisis, the World Health Organization (WHO) classified AMR as a global emergency in 2019. This designation has motivated many nations, including Bangladesh, to adopt policies aimed at strengthening their healthcare systems and addressing health challenges associated with AMR.

CURRENT POLICIES ON IMMUNIZATION AND AMR

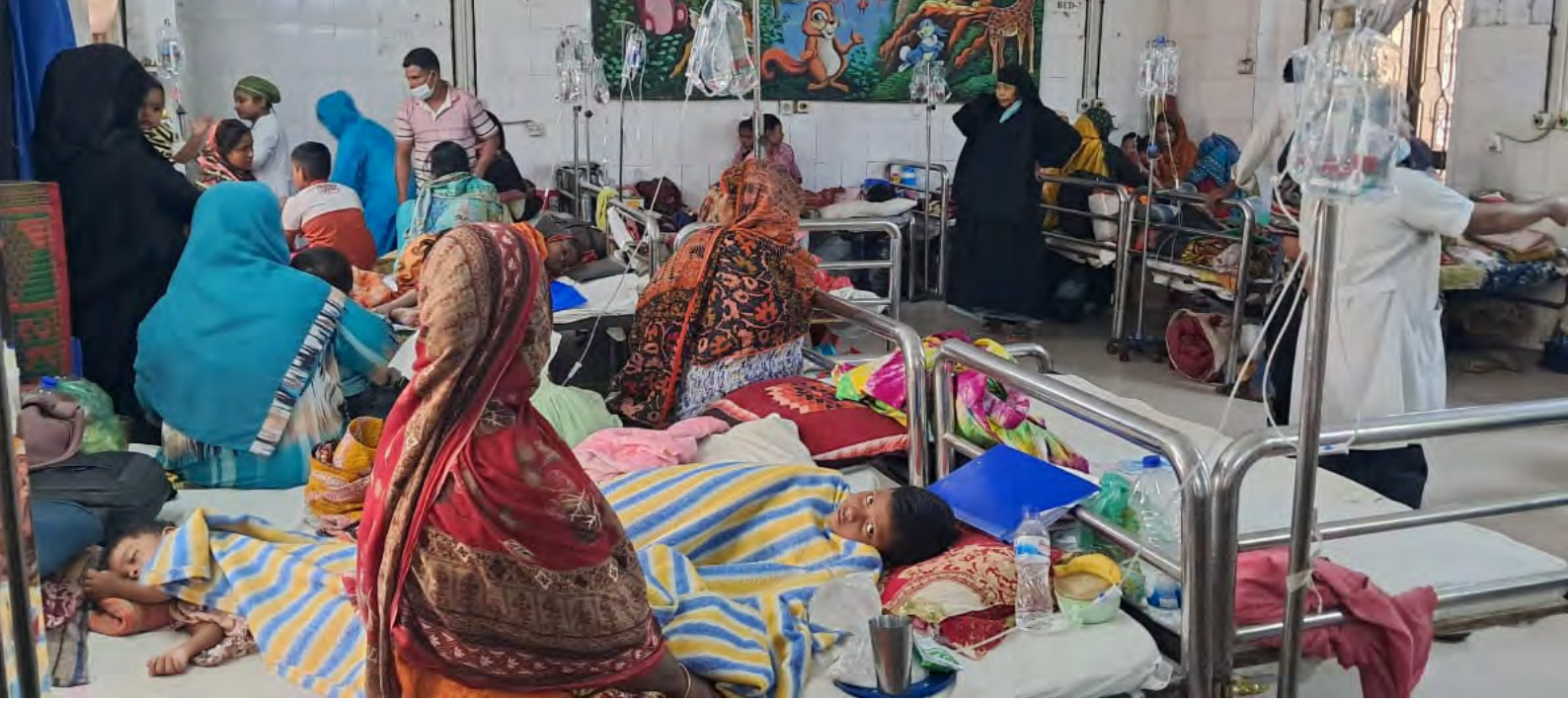
Bangladesh has made notable progress in establishing a decentralized public health care system and in reducing child and maternal death rates. The Expanded Program on Immunization (EPI) has been the cornerstone of this healthcare network. Launched in 1979, the program initially operated on a selective, facility-based model and gradually expanded nationwide by the 1990s.

Immunization services are evenly distributed from the national level down to districts, subdistricts, and smaller localities. Functionally, EPI operates through fixed centers with vaccine storage facilities at the various tiers of public health facilities, and outreach centers based at community-level sites, to ensure optimal coverage.

Detailed mapping and micro-planning efforts focus on hard-to-reach and high-risk areas. Government health assistants serve as vaccinators, and family welfare assistants work at the sites (Jamil et al. 1999; Hossain et al. 2017). Non-governmental organizations (NGOs) also support the program in urban slums (Uddin et al. 2010; Bhuiyan and Haque 2023). Despite advancements in various health service initiatives, the country now faces a looming threat from the rising rates of AMR (Bonna et al. 2022).

The National Action Plan (NAP) for Antimicrobial Resistance Containment in Bangladesh (2017–2022), which has been revised as 'National Strategic Plan for Antimicrobial Resistance Containment in Bangladesh (2021–2026),' aligns with the Global Action Plan on AMR (CDC Division, DGHS 2020; Disease Control Unit, CDC, and DGHS 2017). The NAP includes a roadmap for addressing antibiotic resistance; however, it has yet to emphasize the potential role of vaccines in mitigating AMR.

The Directorate General of Health Services, Director of Disease Control, and Line Director of Communicable Disease Control oversee the coordination of NAP implementation. AMR surveillance networks are managed by the Institute of Epidemiology, Disease Control & Research (IEDCR) for the human health sector; regulation of antimicrobial production, import, sales, and prescriptions in the country falls under the authority of the Directorate General of Drug Administration (Ahmed et al. 2022). However, significant challenges persist in effectively implementing the NAP, particularly in governance and multisectoral collaborations, surveillance, monitoring, and coordination (Ahmed et al. 2022).



INFECTIOUS DISEASE BURDEN AND AMR IN BANGLADESH

Infectious diseases contribute to a significant proportion of avertable disability and mortality in Bangladesh (Table 1) (Perin et al. 2022). The top causal pathogens for infectious disease burden are *Mycobacterium tuberculosis* spp. (cause of tuberculosis), *Streptococcus pneumoniae* (cause of pneumonia), respiratory syncytial virus (RSV) (cause of acute respiratory infections - ARI), *Salmonella typhimurium* (cause of gastrointestinal fevers), and rotavirus (cause of diarrheal disease) (GRAM 2022; IHME 2021). Many of these diseases are avertable through readily available vaccines (WHO 2019a). A report by the Capturing Data on Antimicrobial Resistance Patterns and Trends in Use in Regions of Asia (CAPTURA) consortium (International Vaccine Institute 2022) has described the prevalence of multidrug resistance (MDR) among samples of common infectious bacteria across various laboratories in Bangladesh. Microorganisms frequently linked to hospital-acquired infections display high levels of resistance, such as *Escherichia coli* (60 percent), *Klebsiella pneumoniae* (61 percent), *Pseudomonas aeruginosa* (50 percent), and *Acinetobacter sp.* (76 percent). Moreover, MDR was identified in 46 percent of *Staphylococcus aureus* isolates, 11 percent of *Enterococcus faecalis,* and 22 percent of *Enterococcus faecium* isolates.

*Photo courtesy of Sabeena Ahmed

Table 1. The Burden of Infectious Disease Ranked Against All Causes of Mortality and Disability in Bangladesh (2023)

Rank[a]	Category	Percentage of total deaths	Percentage of total DALYs[b]
6	Respiratory infections, TB	4.34	5.22
8	Enteric infections	2.92	2.83
13	Other infectious diseases	1.09	1.38
-	NTD, malaria	0.26	0.58
-	HIV/AIDS, STIs	0.32	0.50

Source: IHME 2025 a,b
a) Rank represents each infectious disease category's contribution to total DALYs compared to all other causes
b) Disability-adjusted life years (DALYs) describe disease burden in terms of years of life lost prematurely and loss of productive years due to ill health
TB = Tuberculosis; AIDS = acquired immunodeficiency syndrome; HIV = human immunodeficiency virus; NTD = neglected tropical diseases; STI = sexually transmitted infections

Systematic reviews of studies analyzing antibiotic resistance in Bangladesh revealed that 58–100 percent of *E. coli* and *K. pneumoniae* infections were resistant to commonly prescribed antibiotics, including ampicillin, amoxiclav, ciprofloxacin, and co-trimoxazole (Ahmed et al. 2019). Retrospective analysis of stool samples from icddr,b and Dhaka Hospital in 2019–2020, reported that 54 percent of isolated gastrointestinal pathogens were resistant to multiple antibiotics (Garbern et al. 2021).

MDR prevalence was estimated to be 82, 72, 28, and 26 percent for *Aeromonas* spp., *Campylobacter* spp., *Vibrio cholerae*, and *Shigella* spp., respectively (Garbern et al. 2021). Moreover, 17 percent of *Salmonella typhimurium* (typhoid fever) cases reported from two children's hospitals and three laboratory networks in Bangladesh between 2016 and 2019 were found to be MDR (Qamar et al. 2020).

Bangladesh is within the top 30 countries globally with the highest incidence of MDR and rifampicin-resistant tuberculosis (RR-TB), with 1,283 combined cases confirmed in 2022 (WHO 2022).

A systematic review and meta-analysis of antibiotic-resistant pulmonary TB between 1994 and 2014 in Bangladesh estimated a pooled prevalence of drug-resistant and MDR TB of 45 and 22 percent, respectively (Kundu et al. 2020).

The AMR surveillance network in Bangladesh includes 11 sites that collect and share isolate-level AMR data. The most frequently isolated bacteria were *E. coli*, with nearly 34.71 percent of positive records, followed by *Klebsiella* spp., *Pseudomonas* spp., *S. aureus,* and *Enterococcus* spp. (14.51, 10.14, 8.83, and 6.86 percent, respectively). Since 2021, two-point prevalence surveys have been conducted in selected large hospitals to examine patterns of antimicrobial use (AMU) across the country (Sectoral Co-ordination Center (Human Health) for AMR Surveillance and IEDCR 2023).

ANTIMICROBIAL USE AND ACCESS

The widespread and often unregulated use of antibiotics poses significant challenges in the fight against AMR in Bangladesh. A study investigating antibiotic dispensing patterns revealed that half (50.9 percent) of antibiotics were purchased without a prescription (Islam et al. 2022). According to the WHO's AWaRe classification system, which categorizes antibiotics based on their use and potential for resistance, 36.4 percent fell under the "Access" category, 53.6 percent under the "Watch" category, and 10 percent under the "Reserve" category (Islam et al. 2022). For comparison, WHO recommends that the Access group represent a minimum of 60 percent of the total national antibiotic usage to mitigate AMR (Sharland et al. 2022). The Drug Regulatory Authority of Bangladesh prohibits over-the-counter sales of antimicrobials and has worked to reduce medicine prices (DGDA 2016; GARP-Bangladesh National Working Group 2018). However, due to weak enforcement, antimicrobials are still widely available without an appropriate prescription from unlicensed pharmacies and village grocery shops (GARP-Bangladesh National Working Group 2018). It is also critical to ensure proper licensing and training for pharmacy employees and vendors to limit the misuse of prescription-grade drugs, thereby mitigating AMR and associated infections (Islam et al. 2022; Lucas et al. 2019). According to models based on national sample surveys of antimicrobial sales, total human antimicrobial use in Bangladesh was 3.89 defined daily doses (DDD) per capita in 2010, which then increased to 4.43 DDD per capita in 2020. This shows a 28 percent increase from 2010 to 2020. However, the rise in per capita AMU from 2010 to 2020 is below the average global and regional increases of 35 percent and 20 percent, respectively (Sriram et al. 2021). A retrospective study found high levels of antibiotic use in private hospital pharmacies in Dhaka from 2016 to 2021, with 77.1–82.3 percent of total use belonging to the Watch category (International Vaccine Institute 2022). Total consumption fluctuated significantly when measured in terms of DDD, from ~200 to 3,000 per 100 admissions. The study's limitations, the lack of metadata, and the inaccuracies in inpatient admission data emphasized the necessity of a robust antimicrobial consumption surveillance system to help build better strategies for appropriate AMU (International Vaccine Institute 2022).

Consistent with these findings, a global analysis of licensed antimicrobial sales in 2015 found that many of the antimicrobials consumed in Bangladesh had a higher potential for resistance and were recommended only for second-line treatment (Klein et al. 2021). Owing to the increasing resistance to first-line antimicrobials, around 65 percent of antimicrobials sold in 2015 were classified under the WHO Watch category (Klein et al. 2021).

The lack of access to antibiotics is another challenge in the growing AMR problem in Bangladesh. A vast proportion of the population is unable to complete antibiotic treatment courses/regimen, highlighting economic inequities in the country (GARP-Bangladesh National Working Group 2018). A fifth of the population in Bangladesh lives below the international poverty line (GED, Bangladesh Planning Commission 2020), while 73 percent of healthcare expenditures were OOP in 2018 (World Bank 2021). These factors push people to favor unlicensed outlets with lower costs over licensed pharmacies and clinics (GARP-Bangladesh National Working Group 2018).

ANTIBIOTIC USE IN AGRICULTURE

Poultry farming in Bangladesh has emerged as a sustainable source of economic growth, driven by the increasing demand for animal-sourced protein (Rahman et al. 2021). However, this growth has led to the unregulated use of growth promoters, antimicrobials, and probiotics in livestock for medical and nonmedical purposes (Chowdhury et al. 2021; Tasmim et al. 2023). A cross-sectional study on the knowledge, attitudes, and practices related to AMU and AMR among commercial poultry farmers showed that antibiotic misuse largely due to knowledge gaps in understanding proper use, is a major contributor to the rise of AMR (Hassan et al. 2021).

Recent studies analyzing the levels of microbial contamination in food showed the presence of MDR *E. coli* in frequently consumed products, such as tomatoes (14.21 percent) and fish (26.91 percent); *Vibrio cholerae* was found in 44.8 percent of the tested fish, and *Salmonella* was found in chicken (17.27 percent) and tomatoes (7.38 percent) (Samad et al. 2023). Hence, establishing efficient surveillance systems based on a One Health approach is of paramount importance to combat such cases of AMR.

NATIONAL IMMUNIZATION PROGRAM

The EPI in Bangladesh was established in 1979, with vaccines for six vaccine-preventable diseases, targeting children under-five and women of reproductive age in a few townships. Nationwide expansion of the program and coverage targets were achieved by 1990, resulting in the elimination of neonatal tetanus in 2008, polio in 2014, and in controlling congenital rubella syndrome in 2018.

The EPI has expanded over the years to include the hepatitis B vaccine (2003), the *Haemophilus influenzae* type B (Hib) vaccine (2009), the measles-rubella (MR) (2012), pneumococcal conjugate vaccine (PCV) (2015), bivalent oral polio vaccine (OPV) (2016), and fractional dose of inactivated poliovirus vaccine (IPV) in 2017. Human papillomavirus (HPV) vaccine, was officially introduced on October 2, 2023 (Hossen 2023; DGHS 2018), administered to girls aged 10–14 years through a nationwide campaign. Following a recommendation from the NITAG along with technical assistance from Global Alliance for Vaccines and Immunization (GAVI), WHO, and the United Nations Children's Fund (UNICEF), the HPV vaccine has been introduced in the routine immunization program (Hossen 2023). It protects against HPV infections, which are the leading cause of cervical cancer.

The Government of Bangladesh, supported by UNICEF, Gavi, and WHO has also introduced a nationwide typhoid conjugate vaccine (TCV) campaign targeting children and adolescents aged 9 months to under 15 years. Launched in October 2025, the campaign is part of the government's plan to include TCV in the national EPI in the near future (Weyant et al. 2024). Bangladesh has been classified as a typhoid-endemic country. The campaign aims to achieve at least 95 percent vaccination coverage to strengthen immunity within the population and reduce typhoid-related deaths (Gavi 2025).

Another important vaccine against rotavirus, was approved for Gavi support in 2016 and was due to be introduced in 2018 but is still pending implementation as of 2026 (Pecenka et al. 2017; Salahuddin 2016).

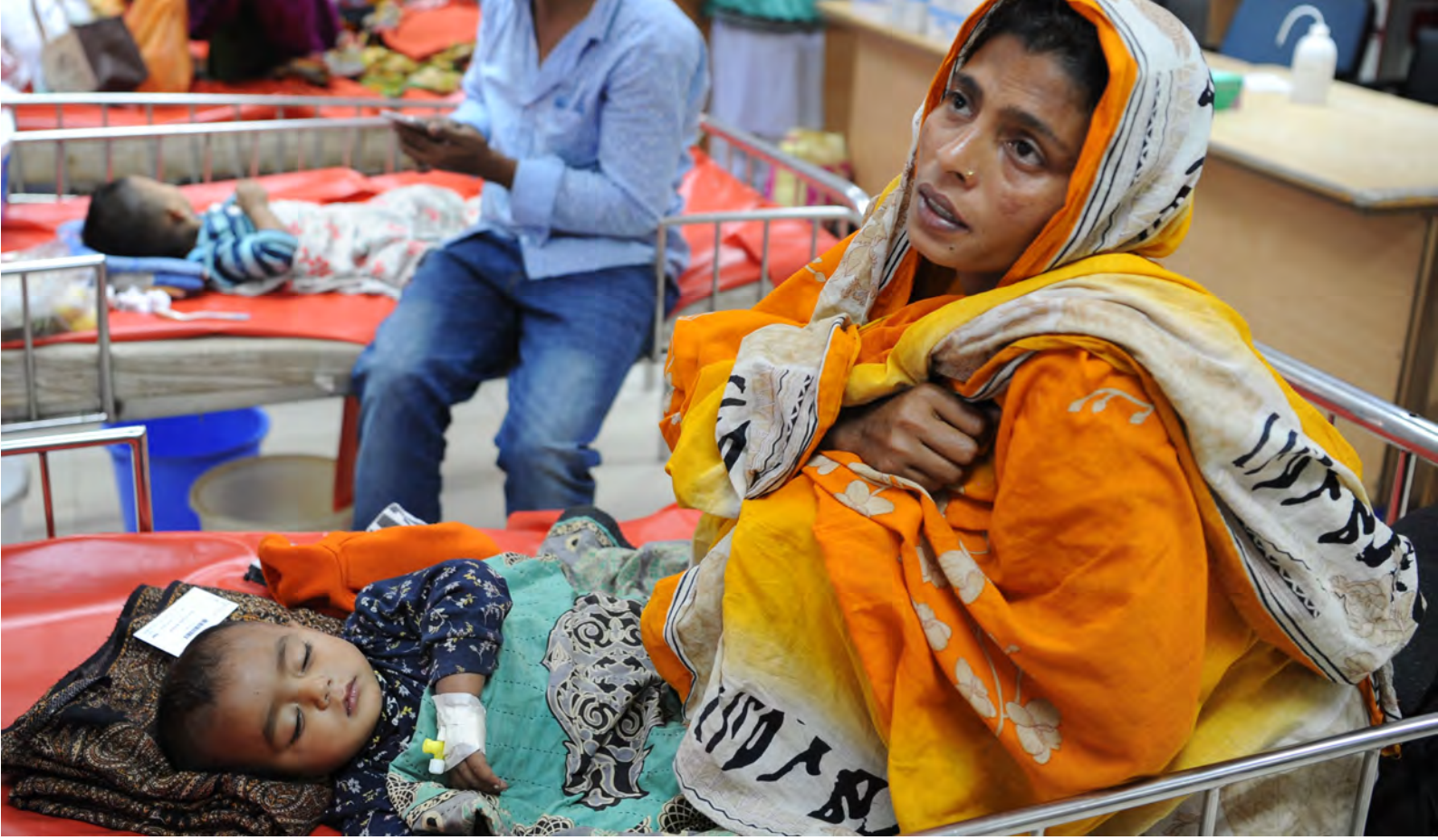
*Photo courtesy of Ching Swe Phru

Table 2. EPI Vaccines and Coverage by the Age of 12 Months

Vaccine	Indication	Dose	2024 coverage (percent)
BCG	Tuberculosis	1	99
PENTA (DPT-Hib-HepB)	Diphtheria, pertussis, tetanus, *Haemophilus influenzae,* hepatitis B	1	99
		2	NA
		3	97
HepB	hepatitis B	3	97
Haemophilus influenzae type b (Hib)	*Haemophilus influenzae*	3	97
Pneumococcal conjugate vaccine (PCV)	Pneumococcal infections	1	NA
		2	NA
		3	97
Oral polio vaccine (OPV)	Polio	1	NA
		2	NA
		3	97
Inactivated polio vaccine (IPV)		1	99
		2	NA
Measles containing vaccine	Measles	1	96
		2	93
Rubella containing vaccine	Rubella	1	96

Source: WHO 2024b

BCG = Bacillus Calmette Guérin vaccine; PENTA (DPT-Hib-Hep B3) = pentavalent vaccine for pertussis, tetanus, *Haemophilus influenzae* Type B, and hepatitis B; OPV = oral polio vaccine; IPV = inactivated polio vaccine; PCV = pneumococcal conjugate vaccine; MR = measles-rubella vaccine. NA = not available



POTENTIAL OF VACCINES TO ADDRESS AMR IN BANGLADESH

In Bangladesh, among every 100 children aged 24–59 months, there are 19.5 cases of invasive pneumococcal disease and 28.1 cases of acute otitis media caused by *Streptococcus pneumoniae* that are treated with antibiotics. The PCV vaccine is estimated to directly prevent 15.6 of these cases (Table 3) (Lewnard et al. 2020). Though PCV vaccines are now regularly used in EPI programs, their use in adult populations, particularly in cases involving chronic diseases and the elderly, is limited mainly to private and tertiary public healthcare facilities.

Other available vaccines like the rotavius vaccine, which is not yet included in the EPI, could substantially reduce annual infection rates and alleviate the national AMR burden. For children under 2 years of age in Bangladesh, rotavirus causes approximately 13.5 antibiotic-treated cases of diarrhea per 100 children. Implementing an appropriate rotavirus vaccination program could prevent about 9 of these cases, representing roughly two-thirds (Lewnard et al. 2020) (Table 3).

*Photo courtesy of icddr;b

Table 3. The Estimated Benefits of Routine Childhood Immunizations for Children Under Five in Bangladesh and Low- and Middle-Income Countries

Vaccine	Age (months)	Antimicrobial-treated cases preventable by direct vaccine effects per 100 children (95% CI)
PCV		ARI attributable to Streptococcus pneumoniae
Bangladesh	24–59	15.6 (2.8–34.4)
LMIC	24–59	19.7 (3.4–43.4)
Rotavirus		Diarrhea attributable to rotavirus
Bangladesh	0–23	9 (1.5–18.2)
LMIC	0–23	11.4 (4–18.6)

Source: Lewnard et al. 2020
ARI = acute respiratory infection; PCV = pneumococcal conjugate vaccine

Models project that vaccinating infants with TCV over the next 10 years could prevent 65 percent of typhoid fever cases and 71 percent of deaths due to fluoroquinolone nonsusceptibility (FQNS). Additionally, it could prevent 67 percent of cases and 68 percent of deaths from MDR typhoid fever (Birger et al. 2022) (Table 4). The TCV program is also expected to include an additional catch-up campaign that would allow unvaccinated children to be immunized, up to age 15. Overall, the program is projected to prevent around 8 million cases, 18,000 deaths, and 1 million DALYs associated with FQNS in typhoid fever, and 3 million cases, 7,000 deaths, and 430,000 DALYs associated with MDR typhoid fever (Table 4) (Birger et al. 2022).

These projections align with empirical evidence from a large cluster-randomised trial in urban Bangladesh, in which 41,344 children were initially vaccinated, followed by an additional 20,412 children who received catch-up doses during subsequent vaccination campaigns. The trial demonstrated that a single-dose regimen of Vi-TT (a type of TCV) was safe, immunogenic, and highly protective against typhoid fever over an average of 17.1 months of follow-up, with an overall vaccine efficacy of 85 percent. Together, these modeling and clinical findings underscore the strong potential of TCV programs to substantially reduce the burden of typhoid fever and antibiotic-resistant infections in endemic settings such as Bangladesh (Qadri et al., 2021)

Studies have also explored vaccination strategies for tuberculosis (TB), another major cause of morbidity and mortality in Bangladesh and a leading contributor to AMR. A recent mathematical modeling study predicted that a routine postexposure TB vaccination program with 50 percent efficacy against symptomatic (active) disease could avert 11 percent of RR-TB cases and 8.4 percent of RR-TB deaths in Bangladesh from 2020 to 2035 (Table 4). The model assumes that 15-year-olds with active TB disease would receive the vaccine, with a two-year catch-up campaign conducted every five years. Projected outcomes are equivalent to 9,800 avoided cases and 1,400 avoided deaths from RR-TB over 15 years. Benefits are anticipated to be even greater if the vaccine is implemented alongside improved RR-TB diagnosis and treatment (Fu et al. 2021). This evidence emphasizes the importance of vaccinations in Bangladesh, reducing the incidence of resistant and non-resistant infectious diseases including pneumonia, rotavirus, TB, and typhoid. This would likely decrease the misuse of antimicrobials to treat symptomatic infections, thereby reducing the downstream selection of AMR bacteria.

Table 4.The Estimated Effect of Vaccines on AMR Cases, Associated Deaths, and DALYs in Bangladesh, South Asia regions, Lower-Income Countries, and Countries Across the Globe

Vaccine	Averted AMR cases		Averted deaths		DALYs
	N	%	N	%	
TCV[a] (10-year prediction)	*Fluoroquinolone non-susceptible typhoid fever*				
Bangladesh	7,904,000	65.4	18,305	71.1	1,191,000
South Asia	31,183,000	59.3	280,540	59.6	16,567,000
Lower-income countries[b]	42,515,000	61.0	506,026	59.6	27,923,000
TCV[a] (10-year prediction)	*Multidrug-resistant typhoid fever*				
Bangladesh	2,781,000	66.6	6,565	67.6	430,000
South Asia	4,609,000	63.2	19,642	60.4	1,197,000
Lower-income countries[b]	21,218,000	65.8	342,725	71.5	16,508,000
TB vaccine[c] (15-year prediction)	*Rifampicin-resistant tuberculosis (RR-TB)*				
Bangladesh	9,800	11	1,400	8.4	—
South-East Asia[d]	286,000	11	62,000	7.5	—
Global	620,000	10	119,000	7.3	—
TB vaccine plus improved RR-TB management[c] (15-year prediction)	*Rifampicin-resistant tuberculosis (RR-TB)*				
Bangladesh	11,000	13	2,100	13	—
South-East Asia[d]	375,000	14	286,000	35	—
Global	831,000	14	499,000	31	—

DALYs = disability-adjusted life years, TCV = typhoid conjugate vaccine, TB = tuberculosis, RR-TB = rifampin-resistant tuberculosis

a) Estimates of TCVs on fluoroquinolone nonsusceptibility typhoid fever and multidrug-resistant typhoid fever. Birger et al. 2022

b) Average for 73 Gavi-eligible lower-income countries. Birger et al. 2022

c) Estimates of the effect of TB vaccines with and without an additional improvement program for RR-TB management. Fu et al. 2021

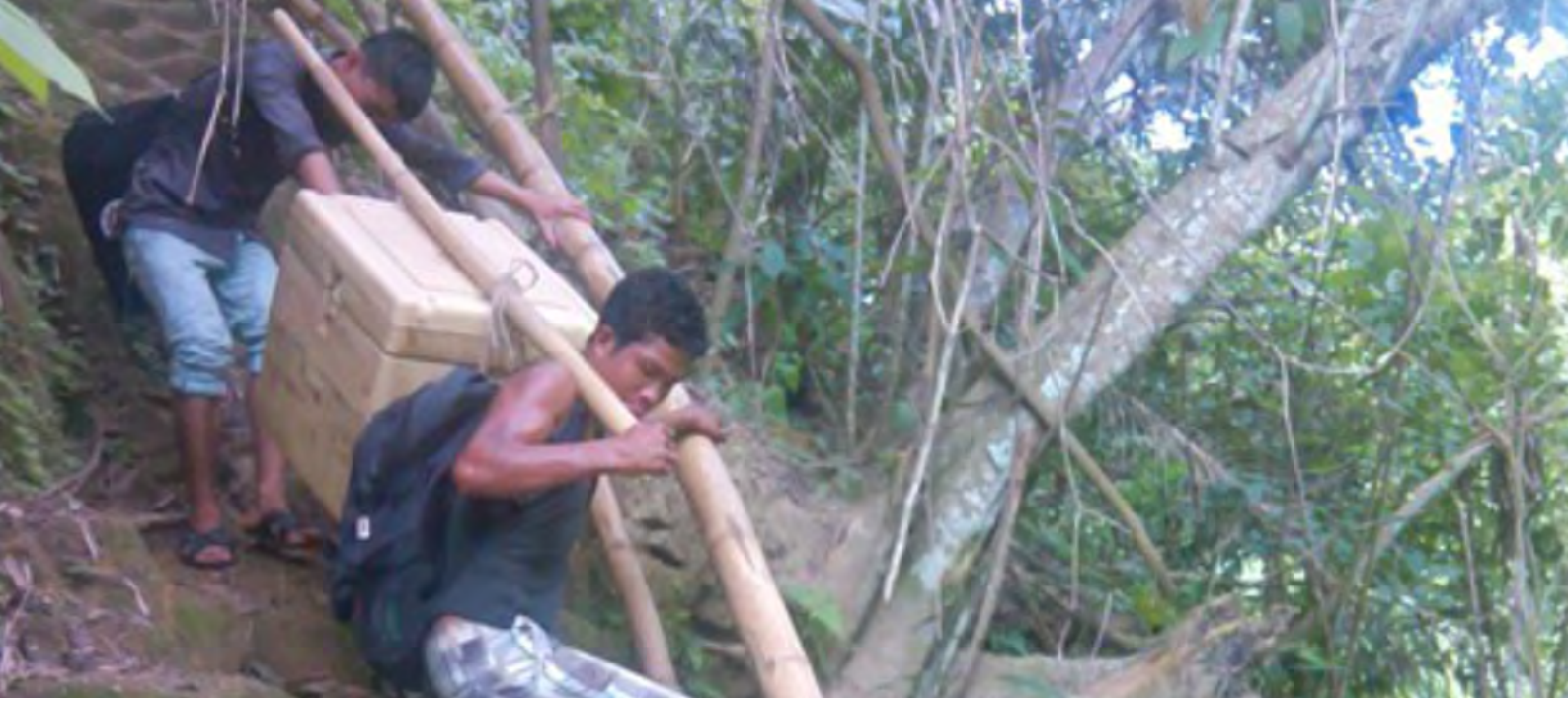
d) Average for the top 30 countries contributing to 90 percent of global RR-TB burden. Fu et al. 2021

ECONOMIC ADVANTAGES OF VACCINES IN COMBATING AMR

By lowering infectious disease incidence and antibiotic use, vaccines represent a cost-effective intervention to address the problem of drug resistance. At the community level, vaccines can prevent catastrophic expenses from the treatment of drug-resistant infections. In 2020, household OOP expenditure amounted to 533 billion taka (6.24 billion USD), which accounts for 68.5 percent of the total health expenditure in Bangladesh. About 65 percent of this expenditure was at retail drug stores and pharmacies, followed by health care professional costs. OOP expenditures for medical and diagnostic procedures also rose from 980 million taka (11.5 million USD) (3.8 percent) in 2007 to 62,433 million taka (731.71 million USD) (11.7 percent) in 2020 (Health Economics Unit, Health Services Division, MoHFW 2023). It is evident that healthcare financing is primarily driven through household expenditure, creating a large burden on individuals and limiting their disposable income (Health Economics Unit, Health Services Division, MoHFW 2023).

Few studies have assessed the economic impact of vaccination on AMR. However, evidence points to the ability of vaccines to reduce AMR by preventing infections that drive antibiotic use, including both resistant and susceptible infections. For example, PCVs can decrease antibiotic consumption by reducing pneumococcal disease incidence and subsequent antibiotic prescriptions, leading to significant public health and economic benefits (Yemeke, Chen, and Ozawa 2023). Vaccinations have shown to reduce treatment and hospitalization costs along with the need for antimicrobials and length of hospital stay (Largeron et al. 2015).

There is a lack of comprehensive studies evaluating the economic value of vaccines in addressing AMR. Existing studies are limited, relying on sparse country-specific data. Few studies provide AMR-related cost estimates or examine vaccine cost-effectiveness in preventing AMR (Yemeke, Chen, and Ozawa 2023). For example, a study on the use of PCV to control AMR in Ethiopia found that 718,100 cases of antibiotic treatment failures could be averted, resulting in annual AMR cost savings of 7.67 million USD over 5 years when compared to a no-vaccination scenario. A systematic review of the cost-effectiveness of vaccination reveals that it can avert 1 DALY for each 100 USD spent (Ozawa et al. 2012). Increasing government expenditure on vaccination programs would reduce the need for OOP expenditure on antimicrobials and other associated costs, decreasing the financial burden on families. This would help Bangladesh reach WHO's goal of working toward universal health coverage by 2030.



ROADBLOCKS IN EXTENDING VACCINE COVERAGE

Covering hard-to-reach areas in Bangladesh remains challenging (Hossain et al. 2017). Areas including the poorest of the population and those displaced have been consistently linked to stagnant coverage for the last decade, along with a high percentage of invalid doses (doses administered outside the recommended immunization schedule, either before the minimum eligible age or after too short an interval between doses) (UNICEF Bangladesh 2021; DGHS 2020). The Coverage Evaluation Survey shows that valid full vaccine coverage by the age of 12 months is about 79.2, 81.8, and 85 percent in urban, hard-to-reach, and rural areas, respectively, falling short of the SDG goal of 95 percent (UNICEF Bangladesh 2021; DGHS 2020).

Despite decades of success, there are weaknesses in the EPI. The immunization delivery system, like other primary health care (PHC) services, is still broadly divided into urban and rural systems. Although the rural part has well-established service delivery points (Upazila Health Complex, Union Subcentres, Upazila Health and Family Welfare Centers, and community Clinics, etc.), its urban counterparts (city corporations) lack such government facilities and largely depend upon NGOs, incurring service charges.

Despite the widespread presence of PHC setups in rural areas, gaps in human resource capacity persist (Uddin et al. 2010). Vacant positions, particularly for health workers and vaccinators in rural settings, hinder the effective delivery of essential services, including immunization programs. To address this, the recruitment and allocation of vaccinators and PHC workers must be aligned with local contexts that serve the population, with a strong focus on hard-to-reach areas. In addition, considering the rapidly growing urban population (roughly 40 percent in 2022) (World Bank 2023c; Bangladesh Bureau of Statistics 2023), the country must think of scaling up coordinated government PHC service delivery points across the city corporations.

Bangladesh has yet to develop an immunization policy or vaccination legislation. Although the EPI has facilitated the development and approval of several strategies, such as the Urban Immunization Strategy, National Immunization Strategy, Continuous Improvement Plan (to strengthen the immunization supply chain), Polio Transition Plan, and Maternal Immunization Readiness Assessment Tool over the last few years, these need to be implemented under an integrated policy. Furthermore, considering the transition out of Gavi support (Hossen 2023) planned for 2029, the country must consider increasing domestic vaccine production. Policymakers should prioritize this issue and increase public–private partnerships to prepare for future needs.

*Photo courtesy of Ching Swe Phru

POLICY RECOMMENDATIONS FOR VACCINES TO TACKLE AMR

AMR comprises a significant public health threat in Bangladesh, causing many infections with limited treatment options. Nevertheless, access to life-saving antimicrobials is crucial to reducing the burden of infectious diseases. Several recent reports worldwide have mentioned the added value of vaccines that alleviate the health and economic burden, AMR incidence, and antibiotic use (Kalanxhi et al. 2023). Available vaccines and those in development can significantly reduce mortality and morbidity rates linked to AMR in Bangladesh and the resulting economic burden from complex therapies for hard-to-treat infections. GARP-Bangladesh proposes the following policy recommendations:

1. Expand the use of licensed vaccines to maximize impact on AMR.
Although the EPI includes most of the basic series of vaccines, introducing TCV, rotavirus, and influenza vaccines could significantly address the AMR-associated health and economic burden. These vaccines are already available in many private facilities, but they also need to be included under national guidelines.

2. Increase coverage of PCV and TB vaccines.
The EPI should also expand to cover vaccination against pathogens that contribute to a significant burden of TB and pneumococcus (both resistant and nonresistant cases) despite the high uptake of available vaccines. These vaccines could be targeted to alternative age groups or pathogen strains to prevent further infections.

3. Ensure and maintain universal uptake of childhood vaccines.
The national childhood immunization program offers seven vaccines that protect against several infectious diseases. In terms of effects on AMR, ensuring high coverage of available childhood vaccines will help reduce the antibiotic use associated with infectious diseases and the incidence of resistant infections.

4. Update existing guidelines.
The recommendations and normative guidance in both the Immunization and AMR sectors must be updated to advance the role of vaccines in controlling AMR. There are opportunities to align immunization and AMR strategies.

5. Develop regulatory and policy mechanisms to accelerate approval and use of new vaccines that can reduce AMR.
COVID-era experiences should be leveraged by regulators and policymakers to address this issue. More health economic impact studies should underline the importance of vaccines in the fight against AMR.

6. Prioritize new vaccine rollouts.
New vaccine candidates capable of reducing the infectious disease burden (resistant and nonresistant) and AMU should receive priority when vaccine regulatory and policy mechanisms are developed. Promising candidates include vaccines or monoclonal antibodies for infections such as RSV and TB, which cause a significant proportion of ARI morbidity and mortality in Bangladeshi children and lack preventive treatment.

7. Ensure richer repositories of data.
Increase collection and analysis of relevant data to assess vaccine impact on AMR, including AMU. Linking the EPI with AMR containment activities could lead to an integrated approach to avert the public health and socioeconomic burden of AMR. Novel health technologies may inform such strategies.

Recommendations to avert infectious disease and reduce AMR in Bangladesh

Vaccine	Target	Estimated impact of vaccine
Ensure and maintain universal uptake.		
PCV (per-year)	**Pneumococcal ARI in children** (24 - 59 months old)	16% of **antibiotic-treated respiratory tract infections** prevented **cases**
Incorporate into the national immunization schedule.		
TCV (over 10 years)	**Typhoid fever cases in infants** (from 9 months old)	67% **cases** 68% **deaths** of **multi-drug resistant typhoid fever** prevented
RotaC (per-year)	**Rotavirus diarrheal cases in children** (under two years old)	9% **cases** of **antibiotic-treated diarrhea** prevented
Prioritize approval of new vaccines relevant to public health and AMR.		
Post exposure TB (over 15 years)	**TB active disease in adolescents** (from 15 years old)	11% **cases** 8% **deaths** of **rifampicin-resistant TB** prevented

Source: Lewnard et al. 2020; Birger et al. 2022; Fu et al. 2021

PCV= Pneumococcal conjugate vaccine, TCV = Typhoid conjugate vaccine, RotaC = Rotavirus vaccine, TB = Tuberculosis, ARI= Acute respiratory tract infection

Data visualized by Lucy Miller.

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Initiated in 2008, the Global Antibiotic Resistance Partnership (GARP) has played a critical role in advancing country-led national strategies and policies to address antimicrobial resistance (AMR) in several countries in Africa and Asia.

GARP's current focus is generating cross-disciplinary evidence highlighting the impact of vaccines on AMR in country-specific contexts.

This policy brief lays out the situation in Bangladesh and recommends policy measures to use vaccines as tools to control AMR in the country.

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