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The Value of Vaccines to Mitigate Antimicrobial Resistance

GARP - Pakistan Policy Brief

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ABBREVIATIONS AND ACRONYMS

AIDS	acquired immunodeficiency syndrome
AMR	antimicrobial resistance
AMU	antimicrobial use
ARI	acute respiratory infections
COPD	chronic obstructive pulmonary disease
DALY	disability-adjusted life year
DRAP	Drug Regulatory Authority of Pakistan
EPI	Expanded Program on Immunization
GBD	Global Burden of Disease
Hib	*Haemophilus influenzae* type B
HIV	human immunodeficiency virus
LMIC	low- and middle-income countries
MDR	multidrug resistance
NTD	neglected tropical diseases
PCV	pneumococcal conjugate vaccine
RSV	respiratory syncytial virus
RR	rifampin-resistant
STI	sexually transmitted infection
TB	tuberculosis
TCV	typhoid conjugate vaccine
UTI	urinary tract infection
VPD	vaccine-preventable diseases
WHO	World Health Organization
XDR	extensively drug-resistant

EXECUTIVE SUMMARY

Antimicrobial resistance (AMR) is a serious global health concern that is making infections hard to treat, and increasing the health and economic burden worldwide. The AMR burden in Pakistan is challenging the treatment of simple infections, leading to treatment failures. For serious conditions, such as sepsis, pneumonia, typhoid fever, and tuberculosis (TB), AMR is significantly increasing mortality rates. Furthermore, disparities in access to health care, education, and basic resources across the country have led to AMR disproportionately impacting vulnerable communities.

Vaccines are an effective tool to combat the growing issue of AMR while reducing the use of expensive antibiotics. Modeling estimates show that vaccines can significantly avert cases and deaths related to several diseases of public health significance in Pakistan. The Expanded Program on Immunization (EPI) was launched in 1978 to prevent childhood infections and lower the mortality rates associated with them. The current EPI covers TB, polio, diphtheria, tetanus, and pertussis, hepatitis B, *Haemophilus influenzae* Type B (Hib), pneumococcus, rotavirus, measles, and typhoid. Effective immunization strategies have lowered the burden of morbidity and mortality in Pakistan; however, morbidity from vaccine-preventable infections, such as varicella, mumps, and hepatitis A is still on the rise. Including vaccines for these diseases in the EPI is expected to further decrease childhood mortality rates.

Although childhood immunization programs have shown moderate success in lowering the burden of infection and the use of antimicrobials in children, adults, particularly elderly people, remain vulnerable. Elderly people, especially those with comorbid conditions, such as diabetes and cardiovascular diseases, are at a higher risk of infections by certain bacteria, such as *Mycobacterium tuberculosis* and *Streptococcus pneumoniae*. Given their susceptibility and weaker immune systems, they can carry these infections and transmit them within the community. To circumvent the epidemic of AMR, adult immunization programs should be included in the immunization policy. Promoting vaccination in adults against influenza, pneumococcal infections, and respiratory syncytial virus, and making the conjugate typhoid vaccine available commercially for adults will significantly impact AMR rates by decreasing the burden of bacterial and viral infections and lowering the demand for antibiotics.

Vaccines in the developmental pipeline can also help slow the emergence of AMR. For example, modeling studies have projected rigorous and novel postexposure TB vaccine programs to be effective in significantly decreasing the burden of drug-resistant infection and death rates, especially if coupled with stronger diagnosis and treatment efforts. Effective implementation of such programs could save tens of thousands of lives in Pakistan alone over the next few decades.

*Photo courtesy of Muhammad Talha Akhtar 2024

To harness the full benefits of vaccines in Pakistan, it is critical to implement and increase coverage for vaccines, such as those against typhoid, pneumococcal infections, mumps-rubella, and rotavirus, in the EPI to lower the infectious disease burden and AMR. Furthermore, it is imperative to maintain and improve immunization rates and introduce programs for adults and elderly people —particularly those with comorbidities. To make this possible, concerted efforts from all stakeholders are needed to manage and improve the EPI and address the burden of infectious diseases and AMR in Pakistan.

INFECTIOUS DISEASE BURDEN AND ANTIMICROBIAL RESISTANCE

Infectious diseases are responsible for a significant proportion of mortality in Pakistan, constituting 194.2 per 100,000 population in 2021 (IHME 2024a). Many of them are preventable through either existing vaccines or those under development (World Health Organization 2024). A substantial amount of the infectious disease burden can be attributed to the following pathogens: *Mycobacterium tuberculosis* (causes tuberculosis (TB)), *Staphylococcus aureus* (causes various serious infections), *Streptococcus pneumoniae, Klebsiella pneumoniae* (causes respiratory infections), *Salmonella enterica* (causes typhoid), and *Escherichia coli* (causes urinary tract infections (UTIs) and diarrhea) (Sharif et al. 2023; Ikuta et al. 2022). Table 1 presents percentages of total deaths and disability-adjusted life years (DALYs: a measure of disease burden in terms of years of life lost prematurely and productive years lost due to ill health), identifying respiratory tract infections as a major contributor to both mortality and morbidity.

Table 1. The Burden of Infectious Disease Ranked Against All Causes of Mortality and Disability in Pakistan, 2021

Rank	Category	Total Deaths (percent)	Total DALYs (percent)
2	Respiratory infections and TB	19.88	14.09
8	Enteric infections	3.10	3.49
13	Other infectious diseases	2.40	2.99
21	NTDs and Malaria	0.63	1.11
22	HIV/AIDS and STIs	0.65	0.79

Source: Institute for Health Metrics and Evaluation (IHME) 2024 b,c
Rank represents each category's contribution to total DALYs compared to all other causes. AIDS = acquired immunodeficiency syndrome; HIV = human immunodeficiency virus; NTD = neglected tropical disease; STI = sexually transmitted infection

Pakistan faces a significant burden of respiratory tract infections, with data from the Global Burden of Disease study showing 55,656 deaths across all ages, 37,745 deaths among children under five, and 8,444 deaths among adults over 70 (IHME 2024a) *Streptococcus pneumoniae* remains the most common pathogen worldwide and alone caused 1.1 million deaths in 2016. In addition, AMR has amplified the crisis; drug-resistant lower respiratory tract infections have the highest AMR impact, leading to 400,000 deaths directly and 1.5 million deaths associated with resistant organisms (Wahl et al. 2018).

South Asia, including Pakistan, has one of the highest burdens of resistant infections, with an estimated 160,517 deaths associated with antibiotic resistance as of 2021 (IHME, University of Oxford 2024d). With high rates of noncommunicable diseases such as diabetes, COPD, and chronic kidney disease, Pakistan's adult population is increasingly vulnerable to severe pneumococcal infections that are difficult and costly to treat due to rising resistance (Khan et al. 2023; Hanada et al. 2021). Introducing and scaling up adult pneumococcal vaccination is therefore both a public health necessity and a strategic AMR containment measure.

Drug-resistant infections impose a significant health and economic burden in low- and middle-income countries (LMICs). Estimates from the Global Burden of Disease (GBD) in 2019 indicated that the South Asian region had the second-highest level of disease burden related

to AMR (21.5 deaths and 892.0 DALYs per 100,000 individuals) among all the superregions (Murray et al. 2022). With 4,601 rifampin resistant (RR) TB cases reported in 2023, Pakistan was ranked among the top seven countries worldwide for the burden of RR or multidrug-resistant (MDR) TB (WHO 2025a). High treatment costs, poverty, and drug shortages pose additional barriers, hindering efforts to lower the burden of TB (Global Tuberculosis Report 2022; Munir et al. 2018).

AMR surveillance data in Pakistan suggest high resistance rates in bacterial pathogens that commonly cause UTIs and typhoid infections. A 2022 study in Islamabad found that 34.4 percent of 1,873 urine samples tested contained MDR strains such as *E. coli* and *S. aureus* (Uppal et al. 2022). Another survey of 2,084 blood-culture-confirmed *S. enterica* typhoid cases found 16 percent of isolates to be MDR (Qamar et al. 2020). MDR typhoid continues to pose a significant health risk, but vaccination has proven effective for mitigating both susceptible and drug-resistant infections. For example, during a drug-resistant typhoid outbreak in 2016 in the Sindh province, an emergency vaccination campaign helped to control it (Jansen et al. 2021).

AMR trends presented by the Pakistan Antimicrobial Susceptibility Surveillance Program (PASS), last made public with 2017-2018 data demonstrated an increasing trend in resistance levels over the years. The report indicated that among *S. typhi* isolates, resistance to first line antibiotics, including ampicillin, chloramphenicol and trimethoprim sulphamethoxazole, was observed at 60 percent. (The National Institute of Health, Pakistan 2018). The situation is more concerning with the emergence of extended-spectrum beta-lactamase isolates of *S. typhi*, which are prevalent in most regions of Pakistan. (Saeed et al. 2020). Typhoid surveillance by Aga Khan University through the SEAP network (2016–2019) revealed that extensively drug-resistant (XDR) *Salmonella typhi* had become more endemic, particularly in Sindh, accounting for approximately 64–70 percent of cases (Klemm et al., 2020; Qamar et al., 2021). Another concerning trend of AMR observed from 2017–2023 is among pneumococcal isolates (465 sputum and other samples) from children under 2 years in rural areas of Sindh. Among 3,140 children, 75 percent were found to have resistant isolates (Nisar et al. 2021).

In LMICs including Pakistan, one-third of children experience at least one episode of *Shigella*-attributable diarrhea during their first two years. Pakistan needs national surveillance for novel and prevalent *Shigella* serogroups. Studies have shown increased rates of resistance among *Shigella* isolates against first-line antibiotic options (The Aga Khan University 2023).

A systematic review of AMR in Pakistan determined that *E. coli* and *S. aureus* were the most frequently reported organisms in invasive infections (2009–2020). The review also found substantial gaps in surveillance outside of provincial capitals and all of the Balochistan province, making it difficult to comprehensively evaluate AMR (Bilal et al. 2021). Investing in molecular research and surveillance would enable a greater understanding of the infectious disease burden and therefore the impact of AMR.

ANTIMICROBIAL USE AND ACCESS

Misuse and inappropriate use of antimicrobials in humans, animals, and agriculture are major drivers of AMR. Models using national sample surveys of antimicrobial sales estimate that antibiotic consumption in Pakistan has increased by 65 percent in 2000–2015, with an average of 1.3 billion defined daily doses in 2015 (Klein et al. 2018). This increase was also exacerbated by a lack of oversight, as a systematic review of the literature (1970–2009) found that 9 percent of antimicrobials in Pakistan were dispensed without a prescription (Morgan et al. 2011). In 2023, antibiotic use was reported in 75 percent of abstracted patient medical records across 14 tertiary care hospitals, with no guidelines or policies for 61.9 percent of the available antibiotics (Ambreen et al. 2023). The global trend also increased by 65 percent (2000–2015) (Klein et al. 2018).

Laws prohibiting over-the-counter sales of antimicrobials have been in place since 1967; however, enforcement has been scant. A 2020 study in Punjab found that nearly all (96.9 percent) of 353 pharmacies and medical stores provided antibiotics without requiring a prescription (Saleem et al. 2020). In addition, a study on antimicrobial use in 76 countries found that 4 percent of antibiotic consumption in Pakistan was classified as "Not Recommended" by the World Health Organization (WHO), referring to inappropriate and unnecessary fixed-dose antibiotic combinations that exacerbate AMR (Klein et al. 2021). A 2019 survey among hospitals in Lahore found that 70.3 percent of the study population had at least one inappropriate antimicrobial treatment, with 71.0 percent of penicillins prescribed for the wrong indication, dosage, or both (Saleem et al. 2019). The pattern of inappropriate Antimicrobial use (AMU) in Pakistan has also increased due to the COVID-19 pandemic. A 2019 study of five hospitals in Punjab found that non-evidence-based antibiotic consumption per bed-day increased as a function of COVID-19 treatment, with azithromycin use increasing by 50 percent in 2019–2020 alone (Ul et al. 2021).

AMU in Pakistan is exacerbated by socioeconomic factors, such as poverty and lack of educational resources. Twenty-two percent of the population lives below the international poverty line (Asian Development Bank (ADB) 2021); for 78 percent of the population, health care expenses are out of pocket, often leading to self-medication (Imran et al. 2022; Afridi et al. 2015). A 2021 survey in two cities in Punjab found that doctors commonly prescribed antibiotics as a prophylactic measure in all hospitalized patients, often lacking the knowledge or resources for appropriate antibiotic stewardship (AMS) programs (Atif et al. 2021). Additionally, a 2023 study in Pakistan found that 57.3 percent of community pharmacists sampled were aware of AMS, 52.1 percent stated that they required more training, and 92.7 percent sought real-time feedback to facilitate its implementation (Hashmi et al. 2023).

THE ROLE OF VACCINES

Vaccines save countless lives every year (Li 2021). In addition to preventing infections, vaccines address many driving factors of AMR, such as transmission of drug-resistant strains and the need for antibiotics to treat primary and secondary infections (Figure 1) (Vekemans et al. 2021). The 13-valent pneumococcal conjugate vaccine (PCV), introduced in 2010 reduced US rates of invasive pneumococcal infections in children under five years by nearly 95 percent overall. For cases caused by PCV13 serotypes, the reduction was even greater (99 percent) (CDC 2024). Furthermore, the influenza vaccine reduced antibiotic prescribing in a population-level study in the United States and among children 2–3 years old in the United Kingdom (Klein et al. 2020; Muller-Pebody et al. 2021).

Quantitative evidence on the impact of the vaccines to address AMR has increased in recent years. A study of 18 LMICs estimated that the PCV and rotavirus vaccines prevented 20 percent of antimicrobial-treated acute respiratory infections (ARIs) in children aged 24–59 months old and 11 percent of antimicrobial-treated diarrhea cases in children under two years old, respectively (Lewnard et al. 2020). Estimates modelled on 2018 vaccine coverage data estimate pneumococcal

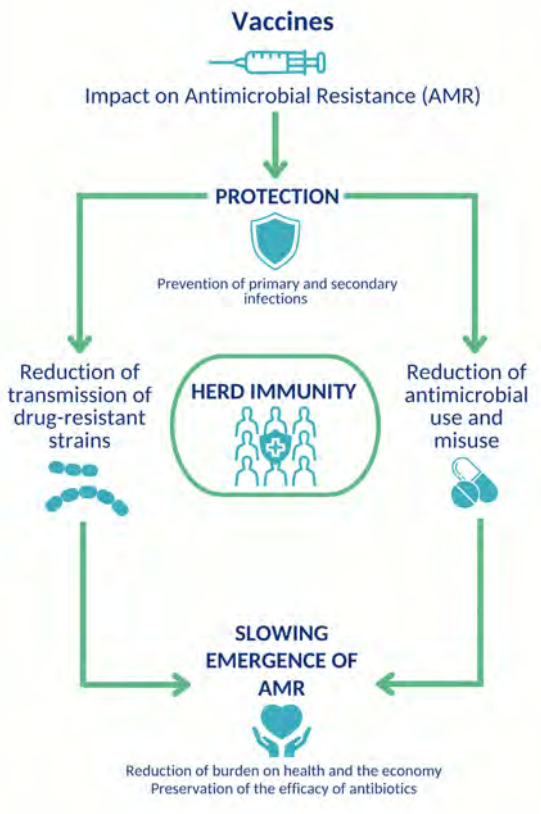

Figure 1. How Vaccination Reduces Incidence of Antimicrobial Resistance

Source: Kalanxhi et al. 2023

*Photo courtesy of Muhammad Talha Akhtar 2024

and rotavirus vaccines to avert 23.8 and 13.6 million episodes of antimicrobial-treated ARI and diarrhea, respectively, for children under five in LMICs each year. Universal coverage for both vaccines could prevent an additional 40 million episodes of antimicrobial-treated illness (Lewnard et al. 2020).

Another modeling study predicted that a typhoid conjugate vaccine (TCV) for infants in 73 lower-income countries could prevent up to 53.5 million cases of drug-resistant typhoid fever after 10 years (Birger et al. 2022).

An action framework titled "Leveraging Vaccines to Reduce Antibiotic Use and Prevent AMR" established by the WHO, Wellcome Trust, Bill & Melinda Gates Foundation, and One Health Trust has highlighted the importance of prioritizing the uptake of vaccines that can mitigate AMR. These include available PCV, TCV, Hib, and influenza vaccines, newly introduced vaccines, such as for malaria, dengue, and respiratory syncytial virus (RSV), and those under development, such as for HIV and group A *Streptococcus*. This framework includes three strategic objectives: enhancing the use of current vaccines, fostering the development of novel vaccines, and amplifying and disseminating knowledge on the vaccine–AMR interplay. Vaccines have been included in national AMR action plans, and we must consider prioritizing these vaccines as one of the major strategies to curtail AMR (Vekemans et al. 2021).

Vaccination prevents serious pneumonia, meningitis, and bloodstream infections, reducing antibiotic use, hospitalizations, ICU admissions, and mortality in high-risk adults. It also offers health system savings by lowering demand for inpatient care and freeing up resources for other critical conditions. For Pakistan, expanding adult vaccine coverage, beginning with older adults and those with chronic diseases, directly supports the AMR National Action Plan, strengthens universal health coverage, and protects the most vulnerable populations, making it an urgent and cost-effective intervention (Torumkuney et al. 2022).

However, despite the vital impact on health, vaccine coverage has stagnated or declined in recent years, and the COVID-19-associated health system challenges and disruptions have exacerbated the situation. Estimates suggest that 21.9 million children under one year did not receive the first dose of the measles vaccine in 2022, compared to the 19.2 million in 2019 (World Health Organization 2024).

POTENTIAL FOR VACCINES IN PAKISTAN

Vaccines could greatly reduce infectious disease burden and antibiotic use in Pakistan for both susceptible and resistant infections. A cohort study in Hyderabad found that the Typbar-TCV vaccine was 95 percent effective against culture-confirmed *S. typhi* among children aged 9 months to 16 years (Yousafzai et al. 2021). Another study demonstrated that introducing a routine TCV infant program along with a 15-year catch up campaign could prevent about 57 percent of MDR typhoid cases and 58 percent of MDR typhoid deaths. Additionally, this campaign could also avert about 58 percent cases of fluroquinolone (FQNS) resistant typhoid fever and over 60 percent FQNS deaths (Birger et al. 2022). It is reasonable to assume that the widespread use of TCV can address the XDR typhoid crisis.

Another modeling study found that a large proportion of antibiotic-treated cases of ARI attributable to *S. pneumoniae* in Pakistan are preventable by vaccination with PCV active against 10 or 13 serotypes of PCV10/13 (Lewnard et al. 2020). Of the 27 antibiotic-treated cases of acute otitis media attributable to *S. pneumoniae* per 100 children aged 2–5, PCV vaccination could avert 15 (Lewnard et al. 2020). The same study also studied diarrhea as a leading cause of antibiotic use among children in 18 LMICs, including Pakistan. Using data from several large-scale household surveys, the study estimated the number of antibiotic-treated case of diarrhea preventable by the live attenuated rotavirus to be nine out of 14 cases per 100 children under 2 (Lewnard et al. 2020) (Table 2).

*Photo courtesy of Muhammad Talha Akhtar 2024

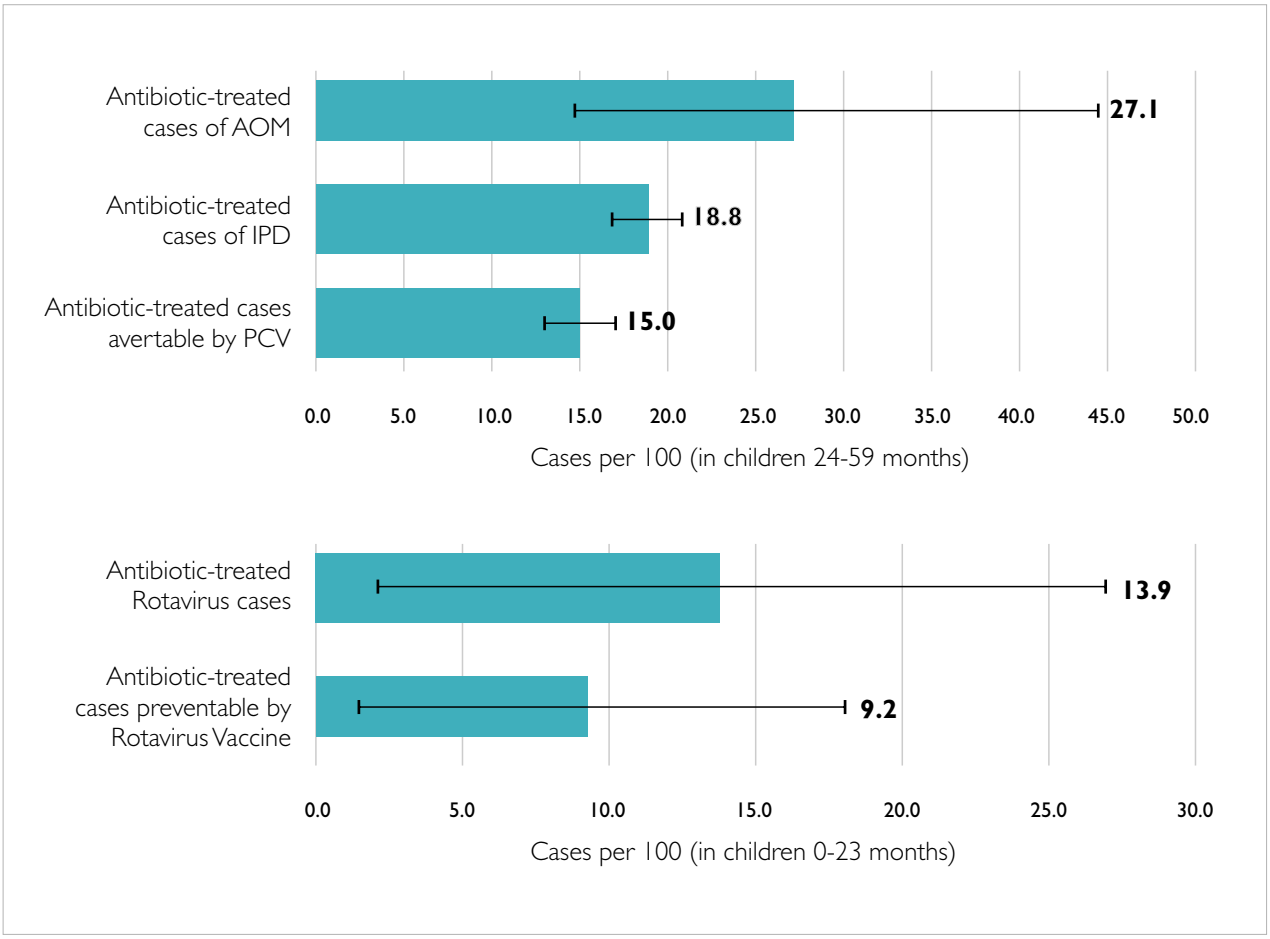

Figure 2. The Estimated Benefits of Routine Immunizations for Children Under Five in Pakistan

Source: Lewnard et al. (2020)

AOM = acute otitis media; IPD = invasive pneumococcal disease; PCV = pneumococcal conjugate vaccine

The WHO established the EPI to decrease the burden of vaccine-preventable diseases (VPDs) worldwide, and it was adopted by Pakistan in 1975 with varying levels of success (Butt et al. 2020). Pakistan's EPI includes 10 vaccinations, with five in the first year and one in the second year. The hepatitis B vaccine (introduced in 2002), Hib (introduced in 2009), PCV10 (2012), inactivated polio vaccine (2015), rotavirus (2017), diphtheria, tetanus, pertussis (DTP) booster in 2018, TCV in 2021 and MR vaccine in 2021 were the newest additions (HISDU, Health and Population Department 2025). Designated centers and outreach initiatives seek to procure and provide free vaccines for children and women of childbearing age (Shahid et al. 2023; UNICEF Pakistan, GAVI, EPI 2018).

However, vaccination efforts also face logistical challenges that need to be addressed, particularly illustrated by polio. Pakistan is one of two countries where polio remains endemic. Survey estimates from 2021 indicate wide variation in vaccination coverage, ranging from as low as 45.1 percent in Balochistan to 94.9 percent in Punjab (Mbaeyi et al. 2022). According to WUENIC 2024, 10–20 percent of children still do not receive the second or third doses of the trivalent vaccine (WHO 2025b). Such challenges need to be considered to realize the full benefits of vaccination nationwide.

Varicella, measles, mumps, rubella (MMR), and hepatitis A are three vaccines that could significantly reduce infectious disease burden and AMR in Pakistan and hence merit inclusion in the EPI. While the MR (measles–rubella) vaccine has already been included as of 2021, the introduction of the MMR vaccine would provide broader protection through the addition of mumps prevention. First, an April 2017 outbreak of varicella in Punjab, which resulted in 18,883 cases, underscored the significance of robust immunization campaigns along with advocacy for immunization (Buliva

et al. 2023). Another study in the Combined Military Hospital in Murree found that only 5.4 percent of children who were vaccinated developed varicella, compared to 66.7 percent in the unvaccinated control group, further stressing the need for a strong community-based vaccination program to prevent such outbreaks (Asghar et al. 2012). More recently, a study identified the varicella M4 virus strain in 66.7 percent of outbreak cases in Punjab and Islamabad. The M4 genotype is a rare genetic variant of the varicella-zoster virus which has been associated with increased disease severity in recent outbreaks (Hanif et al. 2024). Another study reported the average age of pediatric cases to be 5.3 years, with infections clustering seasonally. Adults aged 15–50 years faced more severe complications such as lung failure (Hussain et al. 2025). These findings confirm that varicella continues to pose a serious health risk, highlighting the need for vaccines to prevent future outbreaks.

Despite measles and then MR vaccine introduction, Pakistan experienced 19,444 mumps cases in 2022, with 72.5 percent in the Khyber Pakhtunkhwa province, 9.8 percent in Sindh, and 8.7 percent in Punjab, which could be alleviated with the widespread introduction of the MMR vaccine (Rana et al. 2023). Finally, hepatitis A has been a persistent health concern. A study of primary schools in Sindh found that poor drinking water quality was linked to high rates of infection risk: 35.0 per 10,000 children daily and a 66 percent risk annually in the Karachi district (Ahmed et al. 2020).

Vaccines in the development pipeline have also shown potential in reducing drug-resistant cases and the overall infectious disease burden. A 2021 mathematical modeling study predicted that a routine postexposure TB vaccination program in Pakistan with 50 percent efficacy against symptomatic disease could avert 9.4 and 6.3 percent of RR-TB cases and deaths, respectively over 2020–2035 (Table 3). The model, which assumed routine vaccination of infants at 9 months followed by two-year catch-up campaigns every five years until age 15, projected outcomes equivalent to 36,000 avoided cases and 6,200 avoided deaths over 15 years. Estimates show that more than 53,000 cases and 24,000 deaths are prevented if the vaccine is implemented alongside improved diagnosis and treatment (Birger et al. 2022) (Table 3). Reducing incidence of resistant and nonresistant infectious diseases using TB and typhoid vaccines will likely decrease AMU in treating symptomatic infections, in turn reducing downstream AMR.

Pakistan's EPI should move beyond its current childhood focus and systematically incorporate adult immunization as an essential strategy for combating AMR. Evidence shows that adults, particularly those with comorbidities such as diabetes, cardiovascular disease, cancer, HIV, and other immunological disorders, experience high rates of community-acquired infections, with pneumococcal pneumonia being especially common (O'Brien et al. 2009, Cheong and Song 2024). Since the introduction of childhood pneumococcal vaccination, the burden of invasive pneumococcal disease has shifted predominantly to adults, and a significant proportion of these cases now involve antimicrobial-resistant strains (Ozisik 2025). In Pakistan, influenza vaccine uptake among vulnerable adults remains low. For example, only 6.9 percent of heart failure patients in Karachi and 44 percent of healthcare workers report being vaccinated; though many more express willingness if vaccines were free and accessible (Shaikh et al., 2022, Shahid et al. 2023). Influenza and pneumococcal vaccines are therefore life-saving interventions for vulnerable adults and can substantially reduce inappropriate antibiotic use, hospitalizations, and mortality (Shaikh et al., 2022; Jamali et al., 2013, van Heuvel et al. 2023).

At the same time, Pakistan must address low immunization coverage in high-risk adults and underserved areas (Shaikh et al. 2022). This can be achieved by expanding EPI's reach through public–private partnerships, establishing immunization centers within hospitals to improve vaccine uptake and provide effective education (Jamali et al., 2013). Furthermore, a national vaccine registry should be developed, leveraging public–private collaboration to systematically track immunization records, especially in regions with poor coverage. The recent roll-out of the Zindagi Mehfooz electronic immunization registry (ZM-EIR) in Sindh demonstrates how systematic registration, reminders, and data dashboards improved defaulter tracking and likely contribute to gains in immunization timeliness and coverage in children (Mechael et al. 2024). Together, these measures would strengthen adult vaccine uptake, generate actionable evidence for AMR containment, and build resilience within Pakistan's health system.

Table 2. The Estimated Effect of Vaccines on AMR Cases, Associated Deaths, and DALYs in Pakistan, the South Asia Region, Lower-Income Countries, and Countries Across the Globe

Vaccine	Averted AMR cases		Averted deaths		DALYs
	N	%	N	%	
TCV[a] (10-year prediction)	*Fluoroquinolone-nonsusceptible typhoid fever*				
Pakistan	1,555,000	57.5	3,215	62.5	199,000
South Asia	31,183,000	59.3	280,540	59.6	16,567,000
Lower-income countries[b]	42,515,000	61	506,026	59.6	27,923,000
TCV[a] (10-year prediction)	*Multidrug-resistant typhoid fever*				
Pakistan	1,177,000	56.8	2,473	58.0	150,000
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)	*RR-TB*				
Pakistan	36,000	9.4	6,200	6.3	—
Eastern Mediterranean	47,000	9.5	8,500	6.7	—
Global[d]	620,000	10	119,000	7.3	—
TB vaccine plus improved RR-TB management[c] (15-year prediction)	*RR-TB*				
Pakistan	53,000	14	24,000	24	—
Eastern Mediterranean	66,000	13	26,000	21	—
Global[d]	831,000	14	499,000	31	—

MDR = multidrug-resistant; RR-TB = rifampin-resistant tuberculosis; TCV = typhoid conjugate vaccine

a) Estimates of TCVs on fluoroquinolone-nonsusceptible typhoid fever and multidrug-resistant typhoid fever, from 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, from Fu et al. (2021)

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

RECOMMENDATIONS FOR IMMUNIZATION WITH SCOPE TO TACKLE AMR

Vaccines have significantly reduced infectious disease burdens and are invaluable tools to address AMR, a critical issue in LMICs, such as Pakistan. Effective use of vaccines can prevent many AMR-related problems. The National Action Plan on AMR in Pakistan emphasizes the importance of vaccination in disease prevention. Nevertheless, the country faces challenges in achieving sufficient coverage among children, and adult immunization remains unaddressed. Factors contributing to vaccine underuse for AMR mitigation include poor coverage, limited research, lack of clinical evaluations and epidemiological assessments, policy and economic issues, inadequate production facilities, weak regulatory systems, and insufficient procurement and distribution mechanisms. Gathering and presenting comprehensive data on vaccine use and its effects on AMR to stakeholders and policymakers is crucial for advocacy. The following recommendations emerged from a September 2023 GARP workshop in Pakistan on vaccines to address AMR:

1. Data-Driven Monitoring of Vaccine-Preventable Diseases and AMR Rates

An urgent need exists to establish nationwide surveillance systems for VPDs. These would gather comprehensive data on infections and AMR, aiding in evidence-based policymaking. This data would reveal correlations between vaccination, AMR trends, and infection rates by resistant organisms. Strengthening the WHO Global Antimicrobial and Surveillance System and PASS networks that can achieve this. Ensuring interoperability between these networks is crucial for effective data exchange and reducing redundancy.

2. Establishment of National Antimicrobial Consumption (AMC) Surveillance

Through the Drug Regulatory Authority of Pakistan (DRAP), national AMC surveillance can provide valuable evidence for policymaking, compile important data on antimicrobials, and support the issuance of advisories and user-friendly guidelines.

3. Quality Testing, Pharmacovigilance, and Surveillance of Biological Drugs

The Division of Biological Drugs in DRAP is responsible for assessing, evaluating, and registering biological drugs, including vaccines. To mitigate AMR, it is crucial to explore domestic manufacturing of vaccines, particularly those for typhoid, pneumococcal infections, and rotavirus.

*Photo courtesy of Muhammad Talha Akhtar 2024

4. Capacity Building in the National EPI Program

To address challenges in the EPI, planned interventions must focus on operational costs to address emergency responses and VPD outbreaks, training gaps, low vaccination demand in zero-dose and low-coverage districts due to low awareness and misconceptions, and lack of systematic community engagement. Introducing new vaccines, such as the human papillomavirus vaccine in 2025 and those for malaria, cholera, RSV, and group *B Streptococcus*, will benefit the most vulnerable populations. Comprehensive advocacy requires engaging stakeholders from the federal government, provinces, policymakers, regulatory bodies, such as DRAP, and societies, such as the Pakistan Paediatric Association and Medical Microbiology and Infectious Disease Society of Pakistan. These entities can advocate for vaccines, measure AMR rates and infection outcomes, and support AMR prevention nationally.

5. Development of an Adult Immunization Program with National EPI

The national EPI should include adult immunizations and provide essential vaccines. Influenza and pneumococcal vaccines are life-saving for those with comorbidities, such as diabetes, cardiovascular disease, certain cancers, HIV, and other immunological disorders.

6. Establishing a national centralized provincial data center

To make adult immunizations effective, a robust data-driven policy framework is required. We recommend the development of a centralized provincial data center linked to a national surveillance portal like PASS, enabling continuous transfer and collation of information on etiological agents, resistance patterns, treatment outcomes, hospital stay duration, and antibiotic prescription practices. Data custodians such as the NIH and DG Health Offices should share community-level information with provincial AMR programs to ensure coordinated decision-making.

7. Promotion of the One Health Approach to Combat AMR in Food Animals

Promoting the One Health approach to combat AMR in food animals through vaccines is crucial. Establishing a surveillance program to collect data on antibiotic usage and AMR in the animal health sector is essential. Adopting non-antibiotic alternatives, such as vaccines, is a more effective prophylactic strategy to reduce major infectious diseases, thereby decreasing antibiotic use. For intensive animal farming, this approach is more cost-effective than antibiotic therapy at the flock or herd level. The government must ensure the quality of free vaccines and consider local production of vaccines against prevalent organisms and infectious diseases.

8. One Health Perspective on Shifting to Vaccination in Food Animals

Shifting to vaccination for bacterial diseases in food animals has led to over 80 percent of livestock being vaccinated against major diseases, such as clostridial and Pasteurella infections, and 70–80% of commercial poultry vaccinated against diseases such as fowl cholera, fowl typhoid, colibacillosis, infectious coryza, and mycoplasmosis. This transition from antibiotic use to vaccination significantly reduces antibiotic costs, environmental contamination, and AMR generation in human microbes. Additionally, this approach has fostered self-reliance in local veterinary vaccine production, with five public and three private sector institutions producing vaccines domestically.

CONCLUSION

Improving the immunization rates and achieving universal coverage for vaccines against typhoid, pneumococcal diseases, mumps, rubella, and rotavirus for children and introducing adult vaccines can help prevent many VPDs. Effective implementation of these programs could save tens of thousands of lives in Pakistan over the next few decades. New collaborative efforts are needed to enhance local vaccine production, advocate for vaccine use, monitor antimicrobial use and resistance data in both human and animal sectors, address vaccine shortages and coverage, engage policymakers, and create advocacy materials. Regional manufacturing is crucial for vaccine equity, requiring committed action to ensure sustainability. Including AMR-related endpoints in developing and evaluating vaccines in public and animal health sectors is essential. Evidence of vaccines' impact on AMR should inform policy and investment decisions.

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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 Pakistan and recommends policy measures to use vaccines as tools to control AMR in the country.

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The findings and conclusions contained within are those of the authors and do not necessarily reflect the positions or policies of OHT, Gates Foundation, or partnering institutions. Related research and additional information on vaccines and antimicrobial resistance are available at onehealthtrust.org.

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