



Original Article

Tackling antimicrobial resistance in primary care facilities across Pakistan: Current challenges and implications for the future



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ARTICLE INFO

Article history:

Received 16 September 2023

Received in revised form 28 October 2023

Accepted 30 October 2023

Keywords:

Antibiotic prescribing

Antibiotic dispensing

Retail pharmacy dispensing

Dentist prescribing antibiotics

Hand hygiene

Primary healthcare center

Pakistan

Outpatient departments

Ambulatory care

ABSTRACT

Antibiotics are gradually becoming less effective against bacteria worldwide, and this issue is of particular concern in economically-developing nations like Pakistan. We undertook a scoping review in order to review the literature on antimicrobial use, prescribing, dispensing and the challenges associated with antimicrobial resistance in primary care (PC) settings in Pakistan. Furthermore, this review aims to identify potential solutions to promote appropriate use of antimicrobials in Pakistan. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR) checklist, a comprehensive scoping review was conducted to review the literature of antimicrobials used, prescribed and dispensed in PC settings in Pakistan. Google Scholar and Pub-Med were searched for the period 2000–2023. Papers were analyzed on the basis of eligibility i.e., included antimicrobial use, prescribing and dispensing practices by general population at homes, by prescribers in outpatient departments of hospitals and by pharmacists/dispensers in community pharmacies, respectively. Two researchers analyzed the articles thoroughly and disagreements were resolved through discussion with a third reviewer. Both quantitative and qualitative research studies were eligible for inclusion. Additionally, the selected papers were grouped into different themes. We identified 4070 papers out of which 46 studies satisfied our eligibility criteria. The findings revealed limited understanding of antimicrobial resistance (AMR) by physicians and community pharmacists along with inappropriate practices in prescribing and dispensing antibiotics. Moreover, a notable prevalence of self-medication with antibiotics was observed among the general population, underscoring a lack of awareness and knowledge concerning proper antibiotic usage. Given the clinical and public health implications of AMR, Pakistan must prioritize its policies in PC settings. Healthcare professionals (HCPs) need to reduce inappropriate antibiotic prescribing and dispensing, improve their understanding of the AWaRe (access, watch and reserve antibiotics) classification and guidance, monitor current usage and resistance trends, as well as implement antimicrobial stewardship (ASP) activities starting in targeted locations.

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Introduction

Antimicrobial resistance (AMR) is a global threat arising from the misuse and overuse of antibiotics among humans as well as animals, being compounded by sub-optimal prevention of infection through e.g., vaccination. Antibiotic overuse is very common in low- and middle-income countries (LMICs) such as Pakistan [1,2]. The sparking of resistance is contributed to primary care centers where initial treatment is provided to many patients. Therefore, primary care centers (hospital out-patient/ambulatory departments, community pharmacies and dentists) play a likely major role in emerging cases of AMR in Pakistan. In 2019, globally, there were 4.95 million deaths associated with AMR, which includes 1.27 million deaths directly attributable to AMR [3], with some authors predicting deaths due to AMR could reach 10 million a year by 2050 unless addressed [4]. As a result, potentially exceeding deaths due to cancer [4]. These high mortality rates are a concern, noted by the World Health Organization (WHO), stating in 2017, stating that the global supply of antibiotics is at risk of depletion as current antibiotics in clinical practice are typically derived from modifications to existing classes and exhibit short impact cycles [5]. Even if new antibiotics are found, AMR continues to be a major concern unless there are human behavior changes [6]. In addition to the considerable impact of AMR on morbidity and mortality, there are also considerable economic consequences associated with AMR [7–9]. As a result, AMR is increasing seen as a “Silent Pandemic”, unless addressed [10], requiring international, regional and national initiatives to reduce its burden. [11–15].

Pakistan continues to struggle with a high and increasing prevalence of AMR despite the introduction of the AMR National Action Plan (NAP) [16]. Between 2000 and 2015, there was a 65% increase in antibiotic consumption in Pakistan [17,18], which resulted in Pakistan being the fourth highest consumer of antibiotics among LMIC in 2015 when adjusted for the size of the populations [17]. Of concern, was a 61.5% increase in the utilization of antibiotics in the WHO antibiotic “Watch” group between 2014 and 2018, with the utilization of cephalosporins in the “Reserve” group doubling during this period [19]. This increase was facilitated by the readily availability of ‘Watch’ antibiotics at national level with 8 out of 10 currently marketed antibiotics, alone or in combination, being from the ‘Watch’ list [20,21]. Alongside this, the current extent of inappropriate antimicrobial usage (AMU) as well as a culture of self-medication including the purchasing of antibiotics without a prescription, all contribute to the rise in AMR in Pakistan [21–24]. Coupled with this, a lack of effective diagnostic facilities, a shortage of surveillance systems as well as a habit of aggressively treating patients by typically prescribing and dispensing broad-spectrum antibiotics all encourage the development of AMR [25].

The rising burden of AMR in Pakistan resulted in the development of the NAP [16]. However, there are concerns with its implementation including both personnel and resource issues [26]. In the meantime, healthcare organizations, as well as key health professional groups alongside patients, need to work to protect current antibiotics by ensuring they are used appropriately. A key area of focus is ambulatory care in LMICs as this can account for up to 95% of antibiotic utilization in humans [27,28]. In Pakistan, the PC serves as the initial point for interaction for a large portion of the population, making it an important setting for combating AMR. However, inappropriate practices, including overprescribing and poor adherence to recommendations, promote AMR as well as result in poor patient outcomes, higher healthcare expenses, and avoidable medication-related side effects [18,29]. This is not helped by the fact that most antimicrobials are currently prescribed in Pakistan without culture sensitivity reports and prescriptions.

Consequently, to enhance appropriate use of antibiotics in PC in Pakistan, there is a need to comprehensively review the current

literature on antimicrobial prescribing, dispensing, and usage patterns and the challenges linked with AMR in PC settings in Pakistan. In addition, provide potential ways forward, including policy changes at the provincial level to promote appropriate antibiotic use and battle the increasing danger of AMR in the country. This includes investigating the many factors that contribute to inappropriate prescribing practices while comprehending the obstacles associated with AMR. This also includes investigating the current situation with respect to the NAP in Pakistan in order to give future guidance to healthcare professionals and general population.

Methods

A scoping review was performed to identify the available literature relating to the prescribing, dispensing and use of antimicrobials at the PC level in Pakistan. The PC system serves as the initial point for interaction for an appreciable portion of the population in Pakistan, making it an important setting for combating inappropriate antibiotic use and AMR. In Pakistan, healthcare facilities are classified into three types: primary, secondary, and tertiary care.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist was used to guide the conduct and reporting of this scoping review. The authors subsequently specified the study questions, objectives, search technique, and inclusion/exclusion criteria.

Eligibility criteria

Given the projected scarcity of published literature on the issue, the qualifying criteria were purposefully wide in order to maximize the sensitivity of the search. A manual search of grey literature was also conducted, and relevant references were included. The population-concept-context framework, as proposed by the Joanna Briggs Institute for scoping reviews, was used to develop the research selection criteria [30]. We only included published papers in English, as English is the international scientific language used in Pakistan. Other key characteristics included:

- **Population:** PC i.e., Rural, basic, outpatient department, ambulatory care, community pharmacy, retail pharmacy, physicians, primary-care hospital pharmacist, dispensers, community pharmacists, dentists, health workers and retail pharmacist.
- **Concept:** Antibiotic consumption, prescribing and dispensing knowledge, awareness, common hand hygiene practices, inappropriate prescribing, types of frequently prescribed antimicrobials by physicians and dentists at PC.
- **Context:** Primary care (PC) settings

Recognizing and generating research questions (RQ)

This review focuses solely on the extent of knowledge and awareness, prescribing & dispensing practice, along with the use of antimicrobials among the general population at the PC level. The finalized research questions were:

RQ1: What is the extent of knowledge/awareness, attitude and practice regarding antimicrobials/AMR among healthcare professionals and general population at the PC level?

RQ2: What classes of antibiotics are frequently prescribed, dispensed and used?

RQ3: What is the role of physicians, pharmacists, dispensers, nurses and microbiologists in contributing to AMR or inappropriate use of antibiotics at the PC level?

RQ4: What are the contributing factors to the inappropriate use of antibiotics?

RQ5: What interventions have been implemented at the PC level to avoid AMR including ASPs?

RQ6: How do the relevant studies assess the trend of antimicrobial use at the PC level in Pakistan?

Search strategy

We searched the following databases: Google Scholar and PubMed for the period 2000–2023. The search strategies were drafted according to a database protocol using search terms related to antimicrobial prescribing, antibiotic prescribing, antibiotic dispensing, antibiotic community pharmacy, retail pharmacy dispensing, dentist prescribing antimicrobials, hand hygiene, primary healthcare center, primary level care, Pakistan and outpatient departments, ambulatory care, basic health units, rural health units and irrational prescribing. The “All fields” search option was used.

Study selection

Potentially relevant studies were identified on the basis of their titles and abstracts. Furthermore, the relevant studies were read in full and selected according to the eligibility criteria. (Fig. 1).

Identification and screening of articles

After the removal of duplicates, a total of 4070 articles published were identified. Pre-selection according to title and abstract reduced the articles to 200 for full text analysis, and among them, only 46 fulfilled the pre-established criteria and were included in the final analysis (Fig. 1). The remaining 3740 articles did not fit our inclusion criteria as they were not conducted at the primary care level, did not include antibiotics prescribed to the patients, were not conducted in Pakistan, the study was a review, an editorial or correspondence or the full text of the article was not available or were not in the English language.

Synthesis of results

Data charting

We summarized the key research conclusions of each study as well as organized them in a chart using the following topics after we studied the articles and determined their eligibility: First author, year of publication, study design, study population, sample size, study setting, study duration, knowledge, attitude, practice, objective, commonly used antibiotics, sample, microbes, most resistant antibiotics, most sensitive antibiotics, factors influencing irrational prescribing and conclusion. These topics were subsequently addressed under relevant themes including: Knowledge, attitude & perception: trend of prescribing and dispensing, antimicrobial surveillance, drivers of irrational antibiotic prescribing & suggested interventions, antibacterial stewardship: securing the future strategy, counseling standards, antimicrobial markets and ease of access to ‘Watch’ antibiotics.

Results

Collated findings

Table 1 presents findings from multiple studies focusing on knowledge, attitudes/perceptions, and practices relating to AMR and antibiotic usage in various populations and settings in Pakistan. The studies encompass both quantitative and qualitative research methodologies. Among the key findings, community members, pharmacists, and physicians displayed limited understanding of AMR, while community pharmacists exhibited poor knowledge about appropriate dispensing and inadequate attitudes, with most retailers dispensing non-prescribed antibiotics.

In contrast, HCPs in various healthcare settings demonstrated varying degrees of knowledge, positive attitudes, but mixed practices regarding hand hygiene. The knowledge, attitude, and practice gap were also observed among the general population, with consumers lacking awareness about antibiotic use and engaging in poor prescribing practices. Similar themes emerged among physicians, pharmacy technicians, and non-pharmacist pharmacy workers, emphasizing the need for improved knowledge dissemination, training, and guidelines to enhance rational antibiotic use and mitigate AMR [32,33].

These various studies collectively suggest the necessity for comprehensive interventions to improve future appropriate use of antibiotics. Potential interventions include educational campaigns targeted at all key stakeholder groups, instigation of ASPs among primary healthcare institutions as well as increased awareness generally to address the multifaceted issue of AMR in Pakistan.

Table 2 includes a series of quantitative studies focused on trends in antibiotic prescribing and dispensing practices in Pakistan. The studies cover various settings and populations, employing diverse methodologies to understand the patterns and issues related to antibiotic usage. These studies collectively reveal concerning practices. For instance, community pharmacies in Rawalpindi and Islamabad widely dispense antibiotics without legal prescriptions [34], private practitioners prescribe antibiotics in a higher percentage of cases compared to public sector providers [35], and dental practitioners in different cities exhibit varied habits in antibiotic prescribing [36,37]. Additionally, the trend of irrational prescribing among outpatients is evident, with a notable percentage of antibiotic doses being incorrect or irrational. The studies underscore the need for regulatory interventions, tailored guidelines, education, and quality surveillance systems to enhance rational prescription practices and reduce inappropriate antibiotic usage, thereby mitigating the threat of AMR in Pakistan’s healthcare system.

Table 3 includes a comprehensive overview of studies examining the frequency of commonly prescribed antibiotics, their sensitivity, and resistance patterns among various primary healthcare settings across Pakistan. The quoted studies employed diverse methodologies to investigate antibiotic prescribing practices, focusing on different populations and regions. The research findings revealed significant patterns and variations in antibiotic prescription trends across the country. Commonly prescribed antibiotics included quinolones, cephalosporins, and penicillin, with notable variations based on geographic locations, healthcare facilities, and patient demographics [38,39]. The studies highlighted key concerns, which included high rates of antibiotic prescriptions for essentially viral infections including upper respiratory tract infections (URTI) [40], as well as self-medication and the dispensing of antibiotics without prescriptions particularly during the COVID-19 pandemic [41]. The findings underscore the need for stringent regulatory measures; however, mindful of the economic circumstances of patients especially those struggling to fund both medicines and take time off work to see a physician. In addition, the need for evidence-based guidelines enhanced by the recent availability of the WHO AWaRe book giving treatment guidance for a range of infections in ambulatory care [28,42], as well as educational interventions to enhance rational antibiotic use, combat AMR and enhance patient care within Pakistan’s healthcare system. Our research findings also emphasize the importance of continuous surveillance of AMR patterns to guide empiric prescribing as well as the development of novel antibiotics to address emerging challenges.

Antibiotic stewardship and securing the future

Our findings suggest currently limited application of ASPs in primary care settings in Pakistan [77], which is not helped by typically poor awareness and practices of ASPs among HCPs in Pakistan

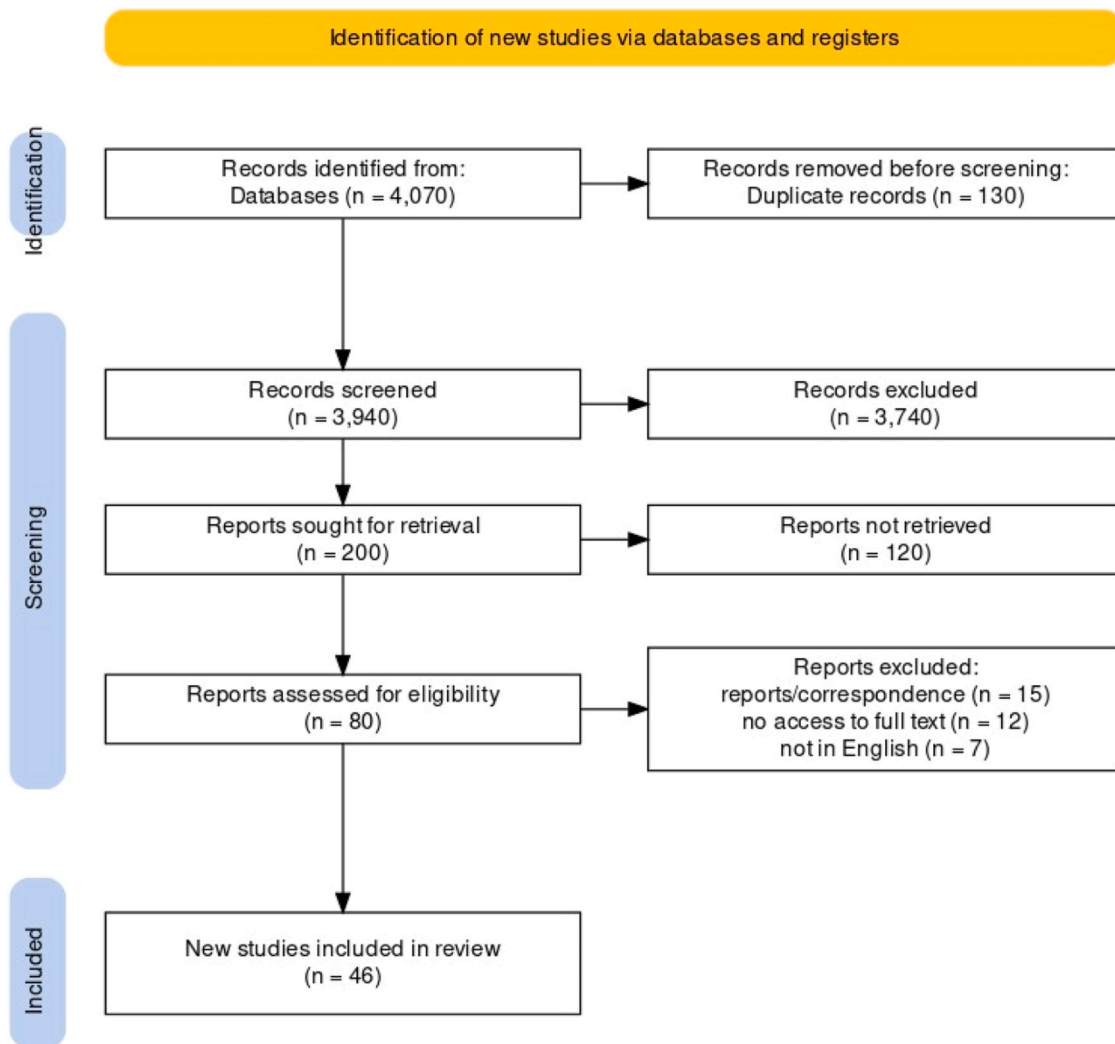


Fig. 1. PRISMA flow chart showing exclusion and inclusion of studies [31].

as well as concerns with instigating these even in tertiary hospitals [78–81]. This is illustrated in a study undertaken among hospital's outpatient departments (OPDs) of Punjab, Pakistan [82]. According to this study, the frequency of ASPs currently practiced in all hospitals in Pakistan is relatively low, and the success of ASPs relies on the adoption of multidisciplinary strategies and the presence of trained staff. Nevertheless, this study is focused on ASP in all types of hospitals with 8% in primary care settings. Furthermore, patient counseling, being a part of ASPs, ensures safe and appropriate antimicrobial use thereby helping to reduce AMR; however, currently such practices are very limited in primary care in Pakistan.

Aziz et al. (2023) recently examined both the standard of antibiotic counselling delivered in community pharmacies and the level of awareness exhibited by pharmacy personnel regarding antibiotic drug interactions [83]. The authors found unsatisfactory antibiotic counseling practices, inadequate antimicrobial knowledge among dispensing staff and absence of guidance regarding antibiotic-drug interactions. This was illustrated by the fact that only 34.1% of the simulated patients were counseled about the antibiotics and only 45% of them received counseling on demand [83]. Alongside this, Mustafa et al. (2022) in their recent study found very low knowledge regarding the core elements and purpose of ASPs among pharmacy technicians working in ambulatory care in Pakistan [48]. This builds on similar findings by Sarwar et al. (2018) among community pharmacists in Pakistan [84]. Having said this, successful ASPs have

been implemented in hospitals in Pakistan providing guidance at the PHC level [85].

Legal framework and challenges for primary care centers in Pakistan

Pakistan has a decentralized health system with autonomous provinces that have their own AMR focal persons. These persons are in charge of setting the health goals, making and implementing plans to tackle AMR at provincial level [86]. Along with that, The National Institute of Health (NIH) being the AMR focal point at the national level under the ministry of NHR & C, monitors and reports AMR in different areas of Pakistan [86]. Despite all the AMR strategies devised by the governing bodies, AMR-related health activities are, yet, not being practiced as a priority in Pakistan because of restricted resources and inadequate funding from Health Department of Pakistan [87]. Therefore, Pakistan, being signatory to international health regulations, has received a caution in a mission report from World Health Organization about the future health and social threats due to negligence of the Health Department of Pakistan in exhibiting poor AMS practices [88].

According to schedule D of Punjab Drug Rules, 2007, antibiotic sales without prescription is prohibited in Pakistan [89]. Whereas, at present, the practice of such a law is minimal in Pakistan and the antimicrobials are being freely sold without any restrictions resulting in high dispensing

Table 1
Summary of knowledge, attitude & perception.

Author, year & Ref	Study Design	Study Population & Sample Size	Study setting	Study Duration	Knowledge	Attitude/Perception	Practices	Conclusion
Hassan Waseem 2019 et al. [43]	Quantitative	community members, pharmacists/pharmacy owners and physicians N = 385	Sialkot Community	3 months (Nov 2018–Jan2019)	Survey shows limited understanding of AMR among community, pharmacists, physicians.	Few members agreed on disposing of the antibiotics with household waste	Qualified pharmacists not present at pharmacy and irrational prescribing by physicians	Study assesses and designs tri- faceted interventions for rationalizing antibiotic consumption and controlling AMR.
Muhammad Majid Aziz et al. 2021 [32]	Qualitative	Community Pharmacies N = 625 Community pharmacist =573 Response rate = 91.7%	Retail Pharmacy Punjab	4 months (Dec,2017– March 2018)	Poor Knowledge about appropriate dispensing	Poor attitude	Majority of the retailers dispensed non-prescribed antibiotics with counselling.	Antibiotics distribution poses infection threat, staff knowledge needs immediate attention.
Muhammad Rehan Sarwar et al. 2018 [44]	Quantitative (Descriptive cross-sectional)	Community Pharmacist 400/414 Response rate = 96.6%	Community Pharmacy Punjab	2 months (April 1,2017 – May 31, 2017)	Good Knowledge	Positive attitude regarding AMS	Poor Practices related to AMS	Incorporation of AMS programs to engage pharmacist in AM-awareness is the need.
Faiz Ullah Khan et al. 2021 [45]	two-phase mixed-methods (quantitative and qualitative) online study	Community Pharmacists N = 180	Community Pharmacy Four Provinces & Azad Jammu & Kashmir & Gilgit Pakistan	8 months (Aug 2019– Mar 2020)	Good knowledge of multidrug-resistant organisms and their roles in ABR	Positive attitude regarding identifying ABR as serious problem.	Acceptable practices i.e., educating patients regarding rational use of antibiotics	Antibiotic stewardship programs, patient education, awareness campaigns, and CP training are essential for timely action.
Masood Hussain Rao et al. 2012 [46]	Quantitative	Doctors, nurses & paramedical staff. N = 3243	Public Sector hospitals of Punjab, KPK, Balochistan, Sindh, Islamabad	-	Majority had knowledge about hand hygiene and its role in reducing transmission of infection	Positive attitude regarding hand hygiene and facilities provided	Most respondents practice hand hygiene with half washing hands for 20 s	25% of tertiary medical centers lack hand washing facilities, but most use them if facilities present.
Muhamad Salmaan et al. 2018 [47]	Quantitative	Pakistani health care professionals N = 260/300 R. R = 89.7%	healthcare settings, (governmental and private) (primary, secondary and tertiary care/specialized centers)	6 months (Nov 2016 – Apr 2017)	Nurses possessed higher knowledge than technicians and doctors.	Positive attitude regarding hand hygiene	Poor hand hygiene practices but nurses and doctors had better practice than the technicians.	Study calls for healthcare workers' education and training.
Zia ul Mustafa et al. 2022 [48]	Quantitative	pharmacy technicians N = 376 R.R = 85.8%	Ambulatory care settings RHC= 37 BHU= 107	-	Majority had good knowledge about antibiotics	-	-	Pharmacy technicians lack awareness of AMR and ASPs.
Faiz Ullah Khan et al. 2020 [49]	Quantitative	General population N = 399 R.R = 88.2%	Community Pharmacies Swat	6 months (April 2019– Sept 2019)	Poor to moderate knowledge about antibiotics	Positive attitude Common perception regarding non-prescription antibiotics	Poor practices related to antibiotic prescribing	Consumers lack knowledge and awareness about antibiotic use; education needed.
Muhammad Atif et al. year 2019 [50]	mixed method study (Quantitative & qualitative)	Participants from the general public N = 400 R. R = 61.5%	Community pharmacies Bahawalpur	2 months (1st June 2018–31st July 2018)	Moderate knowledge related to antibiotics	-	Poor practices related to use of antibiotics, consultation with doctors or pharmacists.	Inappropriate antibiotic use is influenced by factors like health literacy, consultation fees, and availability.
Ali Hassan Gillani et al. 2021 [51]	Quantitative	General population N = 2106/2396 R.R = 87.9%	Punjab (City & village)	4 months (June 2019– Sep 2019)	Majority demonstrated poor knowledge about the antibiotics use	Positive attitude	More than half of the respondents admitted using antibiotics without prescription.	High rate of improper antibiotic usage. There is a need enhance health literacy and monitor antibiotic sales in pharmacy stores
Hina Shan et al. 2019 [52]	Quantitative Study	General Population N = 400	Wah Cantt	12 months (Jan–Dec2017)	Poor knowledge about the antibiotic use, sharing medicines within social circle, using previous antibiotics & using antibiotics for common flu & cold	Positive perception by majority of not considering antibiotics for cold and flu	-	Study shows young, lower-educated, socioeconomically disadvantaged individuals lack knowledge.
Faiz Ullah Khan et al. 2022 [53]	Qualitative	Members of House Holds N = 96	Swat & Shangla	6 months (Nov 2020– Apr2021)	Good knowledge about antibiotics	Positive attitude	Common Practice of storing antibiotics at home and using them	Lack of knowledge related to the appropriate use of leftover antibiotics
Zikria Saleem et al.2019 [33]	Qualitative	Community pharmacists N = 12	Community Pharmacy Lahore	4 months Oct 2017– Jan 2018	Poor Knowledge about antimicrobials	Positive to change	Irrational/unnecessary antibiotic dispensing	Pakistani community pharmacists often err on antimicrobials, requiring multidisciplinary framework for improved use.

(continued on next page)

Table 1 (continued)

Author, year & Ref	Study Design	Study Population & Sample Size	Study setting	Study Duration	Knowledge	Attitude/Perception	Practices	Conclusion
Zikria Saleem et al. 2019 [54]	Qualitative study	Physicians N = 15	Lahore, City	4 months March 2018- June 2018	Poor Knowledge about antibiotic guidelines, ASP	Respondents accepted AMR as a major concern.	Irrational antibiotic prescribing	Addressing inappropriate antimicrobial prescribing in Pakistan improves use and reduces resistance.
Muhammad Atif et al. 2020 [55]	Qualitative study	community pharmacists No. of interviews= 15	Community Pharmacies in Bahawalpur	One Month Oct-Nov 2018	Appropriate knowledge about irrational use of antibiotics	Positive to change and improve if trainings provided	Poor practice of dispensing	Study recommends pharmacist training, medication reconciliation, guidelines, and availability.
Anna Sohail et al. 2020 [56]	Quantitative	Outpatients N = 500	Out-patient Department (OPD) of Institute of Dentistry, CMH Lahore Medical College	-	Inadequate knowledge	-	Bad practice of sharing antibiotics and self-medication	High self-medication rates observed despite antibiotic resistance awareness due to potential misconceptions.
Zikria Saleem 2019 [57]	Quantitative	Physicians N = 200	Hospitals of Lahore	4 months (Dec,2017- Marc,2018)	Well aware about the antibiotic resistance	Physicians agreed that antibiotics are overused nationally.	Inappropriate prescribing of antibiotics	Pharmaceutical representative, Pharmacist, educational sessions, ward rounds, local guidelines etc.
Saima Asghar et al. 2020 [58]	Qualitative study	Non-pharmacist pharmacy workers= 16 No. of pharmacies = 34	Community pharmacies, Bahawalpur	1 month (aug-sep,2018)	Respondents well aware of antibiotics but not antibiotic resistance	Positive to learn and gain knowledge	Inappropriate dispensing of antibiotics	Pharmacist /non-pharmacist staff training, patient education, general public awareness programs, strict regulations and initiatives imposed by government.
Zunaira Akbar et al. 2021 [59]	Quantitative Study	No. of Pharmacists = 100	Community Pharmacies, Lahore	1 month 1st Nov 2017–31st dec 2017	-	Good perception towards antimicrobial stewardship program	Good practice	Gaps need to be addressed along with implementation of guidelines to promote rational use of antibiotics.

ASP= Antimicrobial stewardship program; AMR= antimicrobial resistance; CP= clinical pharmacist

rates in case of “Watch” and “Reserve” antibiotics, consequently, leading to major uncontrollable health concerns [20,90]. The Primary care system in Pakistan, no doubt, is currently the most deprived healthcare system in Pakistan due to compromised infrastructure of health, weak surveillance as well as concentrated health services and budget allocations to secondary and tertiary hospitals [91]. Thus, to achieve universal health coverage(UHC) (at present 45 out of 100),Pakistan (in the National Health Vision 2016–2025) has vowed to increase the provincial and federal health budget up to 3% of GDP as well as promised to prioritize the strategies to improve and functionalize primary healthcare services [91]. Consequently, it is necessary for the government of Pakistan, to initiate national actions to tackle the crucial issues of AMR with more focus on the primary health-care centers through provincial action plans as the latter plays a major role in contributing to the misuse of antimicrobials.

Recommendations

Table 4 contains recommendations for future activities to enhance appropriate antibiotic use in ambulatory care in Pakistan to reduce AMR as part of ongoing goals within the NAP. The AMR National Action Plan aims to ensure the long-term effectiveness of antimicrobials while reducing costs through a consistent, comprehensive, and integrated national policy. The main objectives of NAP include: To enhance antimicrobial resistance awareness as well as understanding by means of efficient interaction, education, and training; enhance knowledge and evidence using surveillance along with research; Reduce the occurrence of infection by implementing adequate sanitation, hygiene, and infection prevention methods; Improve the usage of antimicrobial drugs in both animal and human medicine; Establish an economic rationale for long-term investment that considers all nations’ requirements, and enhance investment in innovative medicines, diagnostic tools, vaccines, and other methods of therapy. The recommendations below have been designed in accordance of the goals of NAP as there are currently major concerns with its implementation.

Discussion

We believe this is the first comprehensive study in Pakistan to document the extent of awareness and practices of physicians, community pharmacists, dispensers, dentists and general population related to antibiotics and ASP at PC level of Pakistan. Among the studies evaluated [43,46,47,49,51–54,56,57], few HCPs in the studies exhibited appreciable knowledge about antibiotics. However, poor practices were observed relevant to their prescribing, dispensing and consumption [71,74,101]. For instance, the majority of physicians in the various studies (Table 1) frequently prescribed antibiotics, including for viral infections, irrespective of guidelines owing to weak surveillance and insufficient guidance. Patient pressure may well play a part as seen for instance in Indonesia where 73.2% of respondents believed antibiotics could treat viral infections and reduce a fever, while 50% stopped using antibiotics after symptoms disappeared, with similar patient pressures seen in other LMICs [102–104]. Antimicrobial prescribing among dentists is also a concern in Pakistan that needs to be addressed going forward [36,37,62,67,75]. This is similar to dentists in other LMICs, who also typically over prescribe antibiotics [105–109].

Of equal concern was that the general population in Pakistan generally appeared happy with sharing antibiotics among family members, especially where co-payments were high, and to purchase antibiotics without prescription. Overall, more than half of the general population surveyed in the various studies (Table 1) purchased antibiotics for viral infections. These high rates are also seen in other LMICs [102,110–115]. However, encouragingly patients were

Table 2
Trends in prescribing, dispensing & consumption of antibiotics in PHC settings in Pakistan.

Author, year & Ref	Objective	Study Design	Study Population & Sample size	Study Setting	Study duration	Prescribing/dispensing pattern	Conclusion
Faisal Imitiaz et al. 2017 [34]	To identify patterns in pharmacy prescriptions and determine self-medication among consumers.	Quantitative	Community Pharmacist No. of Pharmacies = 4 No. of respondents = 386	Community pharmacy Rawalpindi & Islamabad	-	525 antibiotics dispensed to 386 patients, costing 44174 PKR. significant associations found between gender, age, occupation.	Twin Cities pharmacies widely dispense antibiotics without legal prescriptions.
A. Hafeez et al. 2004 [60]	To collect data on prescription practices, dispensing, and patient satisfaction in government facilities.	Quantitative	Common population No. of responses = 914	primary, secondary & tertiary care NWFP, Balochistan and Punjab	2 months	Study finds 52% of prescriptions contain antibiotics; higher among males, larger facilities, younger age groups.	Systems can be enhanced through viable solutions, regular audits, and qualitative investigations.
Sadaf Hayat Laghari et al. 2017 [61]	To assess the trend of irrational prescribing among out-patients.	Quantitative	No. of prescriptions = 500	out-patient settings of Hyderabad city	1 year (Nov 2014–Nov 2015)	37% and 49.6% of antibiotic doses are incorrect, and 60.3% are irrational.	Implementing a quality surveillance system in hospitals on a regular basis can help to enhance rational prescription.
S. Siddiqi et al. 2002 [35]	To analyze the scale of the problem of drug usage (and misuse) in Pakistan's official allopathic health system.	Quantitative	Medical practitioner, prescribers Patient-prescriber encounters (N) = 2300	Public & private sector Attock	1 year 4 months (Oct 1996–Jan 1998)	Private practitioners prescribe antibiotics in 62.3% of cases, compared to 53.9% for public sector providers.	Consumer-targeted interventions improve prescription practices; evaluation research needed.
Farzeen Tanwir et al. 2015 [62]	To study the trend of antibiotic as well as painkiller prescriptions by dentist.	Quantitative Study	Dentists N = 709 patient forms	Institute of oral health sciences, Karachi	2 weeks	Total patient records = 709 Amoxicillin & metronidazole prescribed = 25 44 DDD/100 patients received treatment for caries/pulpitis.	Develop tailored guidelines for optimal antibiotic impact without compromising patient health.
Kashif Ikram et al. 2015 [36]	To examine the incorrect use of antibiotics.	Quantitative Study	private dental practitioners & OPD members N = 500	Dental teaching institutes of Karachi	6 months	Karachi dental surgeons show 100% response rate struggling with antibiotic prescribing.	Regulatory agencies should recommend, prioritize, and implement education on rational antibiotic use.
Farzeen Tanwir et al. 2011 [37]	To define the pattern of antibiotic prescribing and dentists' habits of the Pakistan's significant cities.	Quantitative	Dentists N = 1800	7 major cities of Pakistan Karachi, Multan, Faisalabad, Rawalpindi, Peshawar and Quetta	8 years (2000–2008)	Penicillin was the most prescribed antibiotic for pulpal and dental illnesses.	Guidelines are needed to increase understanding and avoid antibiotic resistance.
Usman Rashid Malik et al. 2021 [63]	Pattern and frequency of dispensing of the antibiotics, without prescription, to be assessed among the children.	Quantitative study (Simulated client study)	Drug Stores = 400/3947	Drug stores (medical store and pharmacies)	2 months (Nov 1st, 19 – Jan 31st, 20)	Antibiotics dispensed without prescription in 59% of simulated visits, 93.2% based on staff advice.	Pakistan's Drug Regulating Authority must enforce strong drug rules to reduce antibiotic use.
Humayun Riaz et al. 2011 [64]	Assess consultants' antimicrobial practices in Pakistan's allopathic health sector.	Quantitative Study	No. of Prescriptions = 4923 No. of Consultants = 197	Lahore, Gujranwala, Sheikhpura, Sialkot & Kasur	8 months (Aug 2008–April 2009)	Drugs dispensed: 480142.313 ± 1.5 average drug per prescription, 20.17% antibiotic encounters in medicine.	Pakistan's irrational drug prescribing demands managerial and regulatory interventions.

PKR= Pakistani rupees; OPD= outpatient department; DDD= daily defined dose

Table 3
Frequency of commonly prescribed antibiotics, their sensitivity and resistance patterns in PHC settings in Pakistan.

Ref. Author & year	Objective	Study Design	Study Population & Sample size	Study Setting	Study duration	Antimicrobials prescribed (N)	Commonly Used antimicrobials			Conclusion
							Antibiotic 1 (%)	Antibiotic 2 (%)	Antibiotic 3 (%)	
Rana Shahbaz et al. 2014 [38]	To assess prescription quality and physicians' antibiotic prescribing practices	Quantitative	No. of prescriptions=355	Community Pharmacies	3 months	-	Quinolones (24.2%)	Cephalosporins (19.8%)	Penicillin (13.66%)	Implement digital prescription system for efficient antibiotic prescribing nationwide.
ABDUL SAMI SHAIKH 2016 [39]	Discusses rational antibiotic prescribing, costs, and challenges in developing monitoring systems in low- and middle-income countries.	Quantitative	No. of prescriptions=428	primary health care facilities (PHC-Fs), public hospitals (PH-Hs), university hospital (UT-H) and private hospitals (PRT-Hs)	-	Generic 60.4% Research brands 39.6%	Quinolone antibacterial (35.0%)	Other beta lactam antibacterials=48.7%	Ciprofloxacin (14.9%)	Physicians must maintain complete prescription records for accurate antibiotic use evaluation and cost reduction
Hania Hashmi et al. 2021 [40]	To record the frequency of URTI-specific antibiotic prescriptions.	Retrospective record review Quantitative study (Prescribing practices)	No. of prescriptions =50,705	public primary healthcare setting	30 days	69.8% prescriptions consisted of antibiotics	Amoxicillin/Clavulanate 1323 (45.9%)	Macrolide group 527 (18.2%),	-	Complete adherence to standards is required, and prescribing antibiotics for URTIs must be avoided.
Noor Sabah Rakishani et al. 2022 [65]	To discuss antibiotic dispensing/ prescribing as well as the underlying variables that influence such practices.	Quantitative (Dispensing & prescribing practices)	physicians, nurses, medical technicians, pharmacy and medicine shop employees, midwives & lady health workers. No. of Respondents = 177	Public & private health care facilities of 14 union councils in Lahore	1 month	-	Amoxicillin/ Augmentin (2.3 [SD 1.5])	Cefixime (2.4 [SD 1.6])	Azithromycin (2.5 [SD 2.1])	Data from this study and comparable studies highlight the critical necessity for all healthcare workers to participate in community-based stewardship program.
Awais Ahmed Ultra et al. 2020 [66]	Examining patient desire and physician approach to antibiotic prescribing.	Retrospective Quantitative	Out-patients with URTIs N = 100	Out-patient department of Hospitals of Punjab	One & half month	N = 100	Amoxicillin = 54%	Clarithromycin = 25%	Others = 16%	Self-care manages most cases, but research gaps exist.
Bushra Gul et al. 2023 [24]	To examine current dispensing trends in Pakistan following COVID-19.	Quantitative	Pharmacies = 39 drug stores =53 No. of prescriptions =11,092	Pharmacies & drug stores	4 months (Nov,2022 till feb, 2023)	N = 8997	Ceftriaxone = 1229 (18.4%)	Amoxicillin = 1033 (15.4%)	Azithromycin = 998 (14.9%)	During the pandemic, significant antibiotic dispensing and 'Watch' antibiotics were observed, requiring urgent attention to reduce AMR.
Sohail Saadat et al. 2013 [67]	To evaluate the antibiotic prescribing behaviors of dentists	Cohort study	Dentists N = 89/110 questionnaires filled R. R= 81%	Public sector dental institute of Karachi	-	-	Amoxicillin 43.3%	Amoxicillin Clavunate 34%	Erythromycin 22.5%	require guidelines based on research for appropriate antibiotic use.
Muhammad Rehan Sarwar et al. 2018 [68]	To study antimicrobial (AM) usage and prescribing trends	Quantitative study	RHC= 16 BHU= 16 No. of prescriptions=	in Punjab, Pakistan's primary health Hospitals (primary care)	1 year (Jan,2016- Dec 2016)	N = 5868 prescriptions with 8236 antimicrobials	Penicillin= 23.6%,	Cephalosporins = 20.1%	Fluoroquinolones = 19.4%	Medical professionals' education and cost-effective regulations might promote judicious antimicrobial use. (continued on next page)

Table 3 (continued)

Ref, Author & year	Objective	Study Design	Study Population & Sample size	Study Setting	Study duration	Antimicrobials prescribed (N)	Commonly Used antimicrobials			Conclusion
							Antibiotic 1 (%)	Antibiotic 2 (%)	Antibiotic 3 (%)	
Shabnam Nazir et al. 2017 [69]	To analyze factors contributing to antibiotic self-medication, affecting healthcare effectiveness.	Quantitative study	Public N = 527/800 respondents	KPK	3 months (Nov 2014–Jan 2015)	N = 135 participants used antibiotics (self-medicated)	Amoxicillin Clavunate = 40%	Ciprofloxacin = 14%	Metronidazole = 11%	The function of community pharmacists must be enhanced.
Tawseef Ahmad et al. 2022 [70]	To assess the amount of antibiotics distribution without a prescription in Hazara Division, KPK, Pakistan.	Quantitative	Community Pharmacies/ medical stores (N) = 310	Community pharmacies Hazara Division	3 months (Nov 2020–Feb 21)	CP dispensed antibiotics = 90.5%	Ciprofloxacin = 46.5%	Azithromycin = 29.4%	Co-amoxiclav = 19.7%	A robust strategy is needed for judicious medication use.
Zikria Saleem et al. 2020 [71]	To determine the amount of present antibiotic sales with no prescription in Pakistani urban regions.	Quantitative	No. of Pharmacies = 353	Community Pharmacy	-	-	Ciprofloxacin 30% (Watch Group)	Linezolid 11.6% (Reserve group)	Metronidazole 10.8% (Access group)	Limiting any dispensing of WHO banned antibiotics without a prescription, is required.
Zikria Saleem et al. 2021 [72]	To examine the pattern of antibiotic use data across different community pharmacies.	multicenter repeated prevalence survey	No. of Pharmacies = 5	Community pharmacies in Lahore	3 months (Oct–Dec 2017)	-	Co-amoxiclav = 1018.15 DDDs	Ciprofloxacin = 486.6 DDDs	Azithromycin = 472.66 DDDs	Policy makers should execute Pakistan's national AMR action plan, which includes restrictions on antibiotic dispensing
Babra Naveed et al. 2022 [73]	Assessing antimicrobial therapy compliance with current guidelines for Streptococcus pharyngitis.	Quantitative	No. of consultation cards = 48	Primary care center located at Nainsukh, Lahore, Pakistan	1 month	20 (41.6%) antibiotic prescriptions i.e., 7 prescriptions met the standards	Amoxicillin No. of patients = 5 (71.4%)	Co-amoxiclav = 2 (28.6%)	-	Clinical audits may improve primary healthcare physicians' care standards.
Muhammad Atif et al. 2016 [74]	To evaluate the practice of prescribing in the emergency department.	Quantitative	Prescriptions = 4320/ 1080,000	Accident & emergency department of Victoria Hospital, Bahawalpur	12 months (1st Jan–31st dec, 2014)	Antibiotics & injections prescribed = 52.4%	Cephalosporins = 81.5%	Penicillin 6.4%	Fluoroquinolones (6.2%)	Frequent irrational medication prescribing requires continuous physician training for accurate care.
Danish Javed et al. 2019 [75]	To support trends and the sensible use of antibiotics in practice of dental procedures & surgeries.	Quantitative	No. of prescriptions = 700	Private dental clinical settings of Sialkot	8 months (Jan–Aug 2018)	751/3445 (drugs) = 21.8%	Amoxicillin Clavulanic acid = 32.9%	Metronidazole 31.8%	Ciprofloxacin 16.1%	Survey shows peripical abscess is the most common dental ailment requiring antibiotics.
Zunaira Akbar et al. 2021 [41]	To evaluate current dispensing trends in Pakistan following COVID-19.	Quantitative	Community pharmacists (N) = 100/ 141	Community Pharmacies, Lahore	2 months (1st Nov 2017 – 31st dec 2017)	Access = 40.3% Watch = 59.2% Reserve = 0.5%	Ceftriaxone = 28%	Azithromycin = 25%	Amoxicillin = 22.4%	Pandemic increases antibiotic administration, including 'Watch' antibiotics, requiring proper pharmacist programs to reduce AMR. (continued on next page)

Table 3 (continued)

Ref. Author & year	Objective	Study Design	Study Population & Sample size	Study Setting	Study duration	Antimicrobials prescribed (N)	Commonly Used antimicrobials			Conclusion
							Antibiotic 1 (%)	Antibiotic 2 (%)	Antibiotic 3 (%)	
Taimoor Hussain et al. 2021 [76]	To identify the bacteria that cause urinary tract infections along with their susceptibility to various antibiotics.	Quantitative study	OPD patients N = 400	Out-patient department Balochistan	9 months	Urine Samples N = 400 Positive for microbes = 266	Escherichia coli = 123/266 (46.24%) Staphylococcus saprophyticus = 59/266 (22.18%) & Klebsiella pneumoniae 49/266 (18.42%)	Ceftriaxone = (64.35%) cefotaxime = (76.54%) ceftazidime = (49.43%) cefepime = (53.44%) levofloxacin = (71.26%) amoxicillin/clavulanate (70.31%)	Fosfomycin, Cefoperazone/Sulbactam, Meropenem, Amoxicillin/Clavulanate	Uro-pathogen monitoring, next generation antibiotics, and rapid diagnostic tests are in urgent need.

URTI =upper respiratory tract infection; DDD=daily defined dose; WHO =World Health Organization

generally positive towards abandoning such practices if adequately guided or counselled providing direction for the future.

The introduction of ASPs, including potential prescribing and dispensing targets, should help to improve appropriate antibiotic utilization in Pakistan (Supplementary Tables S1 and S2). However, there are concerns with current HCPs knowledge and a lack of implementation of ASPs among HCPs working in ambulatory care in Pakistan [77,80,82]. This is similar to other LMICs [116]. However, this is changing and we are beginning to see multiple ASPs being instigated across LMICs typically in hospitals [117–120], progressing now to ambulatory care clinics (Supplementary Table S1).

The published studies also revealed poor practices regarding the dispensing of antibiotics, including without a prescription, as well as a lack of counselling regarding their use and disposal [32,33,43,44,55,58]. Whilst a number of studies demonstrated that a number of community pharmacists possessed sufficient knowledge about antibiotics and AMR; there were concerns about their knowledge relating to potential ASPs [45,48,59] This is a concern as convenient access to antibiotics gives rise to considerable misuse of antibiotics and increasing AMR.

It is evident from the current review that insufficient knowledge and poor practice of patients and community pharmacists regarding antibiotic use is a major contributing factor to increasing AMR at the PHC level of Pakistan. AMR is further enhanced by the extent of ‘Watch’ antibiotics sold as opposed to ‘Access’ antibiotics [20]. There are also considerable concerns regarding current prescribing of antibiotics at the PHC level in Pakistan (Table 3). These prescribing practices also need to be urgently addressed to reverse rising AMR rates in the country. We also see appreciable inappropriate prescribing of antibiotics in ambulatory care in other LMICs [121–128] that also needs to be addressed.

Going forward, the instigation of standard treatment guidelines (STGs) based on the AWARe book, problem-based pharmacotherapy, and pharmacovigilance can also be incorporated into the main medical curriculum in Pakistan to promote implementation of ASP in the healthcare system of Pakistan. These activities can be part of planned educational activities starting in university and continuing post qualification as part of planned ASPs.

AMR is a multidisciplinary, multisectoral, and multi-institutional problem. Qualitative studies may also play an essential role to better understand how to improve the social norms as well as requirements of primary care that impact antibiotic prescription behavior.

We are aware of a number of limitations with this study as we were not able to retrieve 120 studies in the initial screening phase. Firstly, we are aware that this study was not a full systematic review and meta-analysis since we also searched the grey literature. However, we employed a robust methodology. Secondly, we also restricted publications to being in English for the reasons documented for the reasons documented. Thirdly, we did not subject the various publications to a quality check using for instance the Newcastle–Ottawa scale [129–132]. However, this was deliberate as we wanted to be as inclusive as possible to try and fully capture the current situation in primary care in Pakistan. We also did not undertake a thematic analysis as this was difficult due to the variability of the papers included in the review in terms of different methodologies and results reporting. As a result, we categorized several studies based on research questions as displayed in Tables 1, 2 & 3. Consequently, we believe our findings are robust and offer good guidance to all key stakeholders in Pakistan going forward.

Limitations in terms of research gap

Research gaps identified mainly include: No assessment of antibiotic use specifically in the pediatric population at primary care in Pakistan. Not a single study has been identified that specifically focuses on the extent of use of “Watch” and “Reserve” antibiotics in the

Table 4
Research area & recommendations.

Serial#	Research Area	Recommendations
1	Awareness/ perception and human behavior	<p>A. Government/ Ministry of Health (MOH):</p> <ul style="list-style-type: none"> ● Implement stricter laws and policies to improve healthcare governance throughout ambulatory care ● Work with all key stakeholder groups to prepare agreed guidelines (and potential indicators) for the management of infectious diseases in ambulatory care building on the recently launched AWARe book [28,42]. ● Subsequently introduce systems, including potentially mobile telephone applications to regularly monitor prescribing and dispensing practices against agreed guidelines/ indicators and feedback the findings to improve future antibiotic use especially for self-limiting conditions such as URTIs. Agreed guidelines increasingly based on the WHO AWARe Antibiotic Book [92]. Prior to this, the MoH needs to instigate comprehensive drug seller awareness programs and agree on subsequent dispensing practices especially in more rural areas where there can be high co-payments. These can again be based on the WHO AWARe book to limit any dispensing of 'Watch' and 'Reserve' antibiotics, as well as encourage non-antibiotic treatments for essentially self-limiting conditions ● Instigate educational activities among all key stakeholder groups to improve knowledge of antibiotics, AMR and ASPs including working with key Universities to ensure current curricula meets future needs. In addition, instigating pertinent public awareness campaigns surrounding inappropriate use of antibiotics for self-limiting conditions such as URTIs, and monitoring their impact. ● Enhance current AMR surveillance systems building on current activities especially post COVID-19 given resistance concerns [93–95], with the findings used to inform future empiric prescribing ● Uropathogen monitoring, resistance, medications, and diagnostic tests are urgently needed to improve antibiotic use in these indications. These diagnostic tests and surveillance systems can build on activities instigated during the recent COVID-19 pandemic ● Educate pharmacists and the public on any introduced antibiotic self-purchasing restrictions alongside potential alternatives especially for self-limiting viral infection ● Promote handwashing among all key stakeholder groups and ensure necessary detergents and other personal protective equipment (PPE) is readily available at key outlets ● Accelerate the introduction of the National Antimicrobial Stewardship Plan (NASP) in Pakistan involving all key stakeholder groups (https://nasp.nih.org.pk/) ● To execute the NAP, participation of all of the key stakeholders of Pakistan is required. Moreover, separate funding is needed to achieve the goals and outcomes of NAP i.e., to conduct activities to reduce AMR in collaboration with the central as well as state governments. <p>B. Physician/ Physician Societies</p> <ul style="list-style-type: none"> ● Work with all key stakeholder groups to update guidelines and agree potential indicators to enhance appropriate antibiotic prescribing in ambulatory/ primary care – principally based on the recently launched AWARe book ● Work with the MoH to seek ways to introduce electronic records into primary care/ ambulatory care to better monitor prescribing habits building on the ADILA project and App currently being researched in Pakistan (https://www.ndph.ox.ac.uk/news/new-project-aims-to-inform-national-action-plans-to-combat-antimicrobial-resistance; https://cnpi-amr.org/research/adila/). This includes monitoring current prescribing habits in ambulatory/ primary care as a baseline for monitoring the impact of any targeted ASP ● Assist with the introduction of ASPs in ambulatory/ primary care building on successful exemplars in LMICs (Supplementary Table 1). As part of this, instigate pertinent studies in ambulatory/ primary care to evaluate the subsequent impact of ASPs on antibiotic use and clinical outcomes ● Work with Universities to ensure the training of medical students fully captures all aspects of prescribing antibiotics including AMR and ASPs. In addition, seek to improve continuing professional development (CPD) activities were pertinent post qualification to help combat inappropriate education of HCPs by pharmaceutical companies especially where pharmaceutical companies are the main source of information on antibiotics for HCPs [96–98]. <p>C. Dentists/Dental Societies</p> <ul style="list-style-type: none"> ● Dentists must prioritize prescribing antibiotics to immunocompromised patients or to patients at risk of systemic infection due to dental problems. ● There is a greater necessity, in the field of dentistry, to develop and implement prescribing guidelines and standards to avoid irrational prescribing of antibiotics. ● Ongoing education is vital in order to upgrade knowledge regarding antibiotics among the dentists as well as to avoid rising cases of antimicrobial resistance. ● Regulatory authorities need to play an active role to develop prescribing guidelines on the basis of updated literature and regulate the proper use of antibiotics. Guidelines should increasingly be based on the AWARe book, with monitoring increasingly electronic based with 'real time' feedback to prescribers ● There is a greater need to stress correct methods for dental diagnosis to avoid unnecessary prescribing of antibiotics and analgesics [62]. ● The dental professionals should follow proper prescribing protocols and must focus on the need, treatment duration and antibiotic choice to improve future prescribing [99]. <p>D. Pharmacy groups</p> <ul style="list-style-type: none"> ● Work with the MoH to seek ways to enhance appropriate dispensing of antibiotics. This includes instigating guidelines to improve the management of essentially self-limiting conditions similar to other LMICs [100]. Guidelines should increasingly be based on the AWARe book. It is recognized that any Government initiative needs to take account of the availability of different HCPs especially in rural areas as well as issues of co-payments ● Work with Universities to ensure current curricula for pharmacists and technicians fully captures all necessary knowledge of antibiotics, AMR and ASPs given concerns with current knowledge, and seek to enhance CPD activities. ● It is envisaged that Pharmacist should participate actively in the implementation of the AWARe book in the primary care setup, building on their increasing role during the COVID-19 pandemic. ● Agree on possible indicators, and their monitoring, to improve the dispensing of antibiotics among community pharmacies/ medical stores. The should increasingly be based on the AWARe book, with regular monitoring of dispensing practices through mobile technologies and other means ● Help with implementing ASPs in community pharmacies to enhance appropriate dispensing of antibiotics – again increasingly based on the AWARe book to help reduce AMR - building on exemplars among LMICs (Supplementary Table S2) and monitor subsequent activities. Instigate additional ASPs if needed ● Pharmacy leaders to work with community pharmacies/ dispensers to improve the disposal of antibiotics and discourage sharing/ stopping of antibiotics among patients when feeling well in order to keep part-courses for future infections <p>E. Universities</p> <ul style="list-style-type: none"> ● Rapidly appraise current curricula for HCPs regarding antibiotics, AMR and ASPs to ensure this meets current demands. Similarly, for CPD activities ● Continually re-assess the knowledge of key HCPs to ensure their knowledge is adequate especially surrounding the AWARe classification and book, and the implications for future prescribing and dispensing ● Work with all key stakeholder to help implement and monitor the impact of any ASP in ambulatory care, with successful ASPs subsequently used as exemplars. <p>F. Microbiological labs/Implementation of point of care testing:</p> <ul style="list-style-type: none"> ● Rapid antigen diagnostic tests (RADTs) must be advised to identify pertinent pathogens. ● Continuous support and education in the application of POC testing are required, as are systems for monitoring the quality of POC tests in order to reach their full potential. It is likely that the use of POC tests will grow as more become available at affordable costs to healthcare systems and patients

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Table 4 (continued)

Serial#	Research Area	Recommendations
2	Prescribing & dispensing practices (in addition to 1)	<ul style="list-style-type: none"> Regularly conduct research activities with key University personnel and others to monitor prescribing and dispensing patterns against agreed indicators and guidelines. Subsequently, use the findings to instigate future activities if needed to improve future antibiotic use Implement/ expand quality antimicrobial surveillance systems in healthcare institutions Implement non-regulatory and regulatory interventions to enhance healthcare providers' prescription practices. Emphasize accurate diagnosis and contextualized prescription guidelines to improve future prescribing and dispensing of antibiotics Improve medication rationalization through managerial and regulatory actions.
3	Antibacterial stewardship: securing the future strategy	<ul style="list-style-type: none"> ASPs require multifaceted and multidisciplinary strategies involving the participation of all key healthcare professionals, e.g. physicians, pharmacists, microbiologists, nurses and dentists, clinical leadership, and motivated employees to support government efforts to lower AMR rates in Pakistan. Focus on a small set of feasible goals, which is essential for Pakistan.
4	Counseling standards	<ul style="list-style-type: none"> The MoH should establish strategies for community pharmacy services in accordance with current scientific evidence. Staff training on a continual basis would help to enhance patient counselling.

outpatient department of hospitals of Pakistan. It will be highly appreciable if the future researchers identify the key factors behind irrational antibiotic prescribing practices at the primary care level (qualitative studies) in Pakistan.

Conclusion

In conclusion, given the clinical and economic implications of AMR, Pakistan must prioritize its policies in PHC settings. HCPs must appreciably reduce inappropriate antibiotic prescribing and dispensing, improve their understanding of the AWaRe classification and guidance, monitor current usage and resistance trends, as well as increasingly implement ASP activities starting in targeted locations. All of these build on recommendations in Table 4. We will continue to monitor the situation in Pakistan given ongoing concerns.

Funding

The authors extend their appreciation to the Deputyship for Research & Innovation, Ministry of Education in Saudi Arabia for funding this research work through the project number : IFP22UQU4290073DSR204.

Declaration of Competing Interest

The authors confirm that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jiph.2023.10.046.

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