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Applying a gender and equity matrix for a contextualized antimicrobial stewardship intervention in Pakistan

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Abstract

Antimicrobial resistance (AMR) is a growing global health threat that extends beyond biomedical dimensions, as it is profoundly shaped by social and structural determinants such as gender, socioeconomic status, and access to care. However, research exploring these factors remains limited. This study adapts and applies a gender and equity matrix to examine how these factors intersect to affect AMR risks in rural Pakistan. We synthesized literature on antibiotic prescription and use in Pakistan and similar sociocultural and economic context settings, focusing on upper respiratory tract and diarrhoeal infections. We then integrated these findings with insights from a structured consultation with gender and public health experts. The gender and equity matrix mapped inequities across three topic-specific domains—susceptibility/vulnerability to infection, care provision (during facility visits), and care uptake (before and after facility visits)—cross-referenced with biological and social stratifiers along with gender analysis domains. Findings were synthesized into cross-cutting themes to identify actionable drivers of AMR. The context analysis highlighted persistent gender- and equity-related barriers in access to care, including women's limited mobility, lower health literacy, and restricted decision-making autonomy. We also identified structural constraints, including limited household financial resources that result in women being deprioritized for care, alongside gender-insensitive health care service delivery. In rural low- and middle-income countries' settings, addressing these barriers requires gender-responsive health system design, equitable provider–patient communication, and interventions that reduce economic and physical barriers to care uptake. The gender and equity matrix offers a structured approach to reveal how social and structural determinants interact to drive AMR risks, providing a practical tool for systematically integrating gender and equity considerations into AMR policy and programming.

Keywords gender, equity, antimicrobial resistance, context, matrix, rural

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Key messages

- Antimicrobial resistance (AMR) is shaped not only by biological and clinical factors but also by social and structural determinants, including gender norms, household power dynamics, and health system constraints. These factors remain largely unexplored in low- and middle-income countries (LMIC), particularly rural settings. The existing research often examines the effect of these determinants in isolation, limiting understanding of their combined effect on AMR risks.
- The study utilizes an adapted gender and equity matrix to systematically map inequities in domains associated with key drivers of AMR: infection susceptibility/vulnerability, care provision, and care uptake. It demonstrates how intersectional influence of gendered and structural conditions affects AMR risks in public primary health care centres in rural Pakistan, providing insights relevant to other LMIC health systems.
- Integrating gender and equity considerations into AMR programming can improve antibiotic use and care outcomes. This includes addressing household decision-making dynamics, provider biases, structural barriers, and facility accessibility issues. Building provider capacity and embedding gender- and equity-responsive policies at the facility level are critical for sustainable improvements.
- An intersectional, integrated approach offers a framework directly usable by policymakers and implementers. Tailored interventions—such as inclusive communication strategies, community engagement, and supportive institutional policies—can strengthen antimicrobial stewardship and enhance equitable healthcare delivery in rural LMIC contexts.

Introduction

Antimicrobial resistance (AMR) is a major global health threat because it makes infections harder to treat, requiring more potent medicines, leading to longer illnesses, higher costs, and increased mortality (Ho et al. 2025). AMR has been responsible for more than 4.71 million deaths in 2021, making it one of the most urgent global health issues of recent times (Naghavi et al. 2024). In addition to the necessary medical measures, there has been global emphasis on understanding AMR through a sociocultural lens (Keenan et al. 2025, Melaku and Assegid 2025). This requires going beyond individual behaviours to consider how shared values and beliefs along with social, structural, and systemic factors influence two key aspects of AMR development (The Lancet Regional Health-Western 2024), i.e. the prescription practices of healthcare providers and the antibiotic consumption patterns of patients (Charani et al. 2021, The Lancet Regional Health-Western 2024). Prescription and consumption practices are shaped by deeply embedded gender and social norms, power relations, cultural practices, and material inequalities (Ayukekbong et al. 2017, Tompson and Chandler 2021, Papadimou et al. 2022, Gautron et al. 2023). However, such dynamics remain underexplored in AMR research and programming, particularly in low- and middle-income countries (LMICs). Given the recent global emphasis on incorporating gender and equity considerations in the global action plan on AMR (Batheja et al. 2025b) to subsequently inform regional policies and actions, it is imperative to understand these dynamics in different contexts. Moreover, conducting gender and equity analysis before implementation of an intervention to improve antimicrobial stewardship can be highly valuable in improving uptake and acceptability, further enhancing the potential for scalability (Tannenbaum et al. 2016, Kalbarczyk et al. 2025, Batheja et al. 2025a).

The rural areas in Pakistan present a particularly critical context for AMR due to the combined effects of limited healthcare access, informal antibiotic use, weak regulation, and entrenched social and gender norms that shape care-seeking behaviours and treatment choices (Yau et al. 2021, Vitiello and Zovi 2025). These disparities can influence the overuse, underuse, or misuse of antibiotics (Tompson and Chandler 2021). Moreover, healthcare providers themselves do not operate in a vacuum; their prescribing behaviours are shaped by the same social structures that affect patients (Tompson et al. 2021). Understanding how these provider-side dynamics interact with community healthcare and access patterns is essential for designing more effective and equitable AMR mitigation interventions, but this remains significantly under-studied. A recent scoping review on the role of gender in AMR reflected on this and reported that, out of 141 eligible studies published over the last 25 years, <15% were from the WHO EMRO region, highlighting a major knowledge gap within the region (Ruckert et al. 2025). This gap is likely even more pronounced in rural localities.

Pakistan's rural healthcare system, serving about two-thirds of the country's population (Ullah 2022), is characterized by a mix of formal and informal providers, fragmented service delivery, and limited regulatory oversight (Ali et al. 2021, Muhammad et al. 2023). Among formal providers, publicly funded primary care is mainly delivered through rural health centres (RHCs) (Tahir et al. 2024) where around 60% of antibiotic prescriptions in 2017 were inappropriate (unnecessary or incorrect antibiotic use) (Sarwar et al. 2018b). Access to quality care remains unequal, with women and socially marginalized groups often facing multiple layers of disadvantage when seeking or receiving appropriate treatment, even for common infections (Habib et al. 2021, Khadija et al. 2025).

Recent evidence underscores an urgent need for contextualized antimicrobial stewardship activities (Alam et al. 2023) to prevent a significant public health crisis in Pakistan. Despite this urgency, there are currently no national or provincial guidelines to support empirical prescribing at the primary care level. In response, the authors' organisation is conducting a multicomponent project aimed at developing and implementing a grounded and replicable intervention to promote appropriate antibiotic prescribing and responsible consumption at public primary healthcare facilities. This intervention focuses on adolescents and adults with acute upper respiratory infections or diarrhoea, the most commonly reported conditions at RHCs in Punjab, Pakistan (Directorate General Health Services 2024). Because RHCs are primarily attended by disadvantaged populations (Abbas and Talib 2024), ensuring that the intervention is gender and equity responsive is a key consideration.

In line with global recommendations to support the design of more equitable and context-sensitive AMR interventions (Lynch

Table 1 Summary of study design and methods.

Step	Description
1. Gender and equity matrix contextualising	Adapted the gender and equity matrix to focus on antibiotic prescription and consumption in rural Punjab. The gender analysis domains from established frameworks were retained, while three topic-specific domains (susceptibility/vulnerability, care provision, care uptake) and seven biological/social stratifiers (sex, age, education, marital status, occupation, housing conditions, physical/social disadvantage) were developed using a causal loop logic model and expert consultation.
2. Evidence gathering and matrix population	Populated the matrix using evidence about antibiotic prescription and consumption from literature (PubMed, Scopus, CINAHL, Google Scholar; 2010–2024, prioritizing Pakistan followed by countries with similar socioeconomic and sociocultural background), field insights from ASD and expert inputs. Broad scoping searches mapped available evidence; targeted searches addressed domain-specific gaps.
3. Participatory expert validation and refinement	Engaged local experts in gender, equity, and health to review the populated matrix and provide verbal and written feedback, ensuring contextual, cultural, and institutional relevance.

et al. 2024, Marcelin et al. 2024), this study applies and adapts a gender and equity matrix to analyse how gender roles, norms, and inequities—alongside other intersecting social factors—shape provider and patient decisions regarding antibiotic use in rural Pakistan. In doing so, we generate recommendations to strengthen the gender and equity responsiveness of our ongoing antimicrobial stewardship activities at public primary healthcare level in Pakistan and demonstrate the broader value of the matrix as a methodological tool for integrating social determinants into AMR policy and programming. We conducted a gender- and equity-focused context analysis to examine how biological and social stratifiers, in conjunction with established gender analysis domains, influence two critical areas for AMR control in Pakistan: appropriate prescription and responsible consumption of antibiotics. These are also the two areas of focus in our ongoing AMR intervention.

Methods

This multistep mixed-method study was conducted to analyse and understand the AMR context from a gender and equity lens in rural Punjab, Pakistan. Punjab is the most populated province of Pakistan with a population of more than 125 million, around 60% of which are living in rural areas according to 2023 census (CityPopulation.de 2025). According to recent data from provincial government, there are 326 rural health centres in Punjab (Punjab Health and Population Department 2025).

We adapted the gender and equity matrix, a structured applied analytical tool for context analysis, derived from widely used conceptual gender analysis frameworks (Jhpiego 2016, Morgan et al. 2016, World Health Organization 2020, Morgan et al. 2022a, Morgan et al. 2022b), to systematically organize and synthesize evidence from diverse sources. The approach was guided by the 'Practical Pathways to integrating gender and equity considerations in AMR research' (Lynch et al. 2023) and selected for its capacity to integrate multiple forms of data, map relationships across biological, social, and structural factors, and generate insights relevant to LMIC policy and practice in AMR context, where health inequities are often embedded in both service delivery and broader social systems. The matrix also offers added flexibility as compared with existing approaches (World Health Organization 2018, Emdin et al. 2025), as it can be applied in human, animal, or environmental AMR interventions. Moreover, its ability to include social and biological stratifiers alongside the gender analysis domains ensures that equity and intersectionality remain the focus of analysis.

Our methods comprised three main stages: contextualizing the gender and equity matrix and defining study-specific domains and stratifiers; populating the matrix with evidence from literature and field insights; and validating and refining the matrix through expert review (Table 1).

Contextualizing the gender and equity matrix framework

The matrix comprises three components (Lynch et al. 2023): gender analysis domains, topic-specific domains, and biological and social stratifiers. In line with established guidance for applying the matrix, the gender analysis domains—common across most sociocultural settings—were retained without modification (Jhpiego 2016, Morgan et al. 2016, World Health Organization 2020, Morgan et al. 2022a). These include five thematic areas where gender inequalities commonly manifest: access to and control over resources; distribution of labour, practices, and roles; social norms, values, and beliefs; decision-making power and autonomy; and policies, laws, and institutions (Morgan et al. 2016).

In contrast, the topic-specific domains and stratifiers were customized to reflect the study's focus on appropriate antibiotic prescription and responsible consumption in rural healthcare centres in Pakistan. This tailoring was achieved through an iterative, consultative process combining systems thinking with contextual expertise. A core expert group was formed with individuals from the public health system, implementation research, and gender and development, bringing both technical and managerial expertise. Moderated by a senior public health professional, the group unpacked the two focus areas of this study—appropriate prescription and responsible

consumption—to identify directly related subdomains. Using a causal loop logic model (Cassidy et al. 2022), the team synthesized these subdomains into three broader topic-specific domains that reflected the study's focus:

1. Susceptibility/vulnerability to infection: combining intrinsic biological determinants (susceptibility) and extrinsic socio-economic conditions (vulnerability) that influence both risk of acquiring infection and severity of outcomes.
2. Care provision: encompassing both clinical and non-clinical aspects of the patient experience during a facility visit, including diagnostic practices, communication, privacy, and respectfulness of care.
3. Care uptake: covering the continuum of experiences before and after a facility visit, including care-seeking decisions, adherence to treatment, and follow-up.

Context-specific biological and social stratifiers were identified in two steps i.e. a literature review to compile a comprehensive list of potentially relevant stratifiers followed by refinement through core expert group and project team consultation to select those most salient in the local context. The seven selected stratifiers were sex, age, education level, marital status, occupation, housing conditions (size and ownership), and physical/social disadvantage (such as stigma and communication difficulties).

Populating the gender and equity matrix

The matrix was populated using evidence from published literature, field insights from the implementing organization, which has over three decades of experience delivering healthcare interventions in the study setting and consultation with local subject matter experts. The source of each entry in the matrix was explicitly recorded (Table 2). Moreover, citations are also included if the findings were linked with published literature.

Literature review

The literature review targeted the overlap of the three topic-specific domains and the selected biological and social stratifiers. We developed a comprehensive search strategy following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, using predefined keywords related to antimicrobial resistance (e.g. antibiotic resistance, antibiotic prescribing, self-medication), infection susceptibility, care provision/uptake (e.g. healthcare delivery, treatment adherence), and biological and social stratifiers (e.g. sex, gender, age, education, marital status, occupation, residence, disability). Associated keywords for the stratifiers were also included such as cisgender/non-binary (gender identity), living conditions/occupancy/habitation (residence), and disadvantaged/stigmatized/vulnerable populations (disability).

Searches were conducted in PubMed, Scopus, and CINAHL, supplemented by Google Scholar to capture relevant grey literature. All the publications in English language between January, 2010 and December, 2024 were included. The review followed a staged approach, beginning with broad scoping searches to map the range of available evidence, followed by targeted searches to address domain-specific gaps and populate the matrix with more detailed evidence. The literature review was conducted in parallel by two individuals and then co-synthesized before getting populated in the matrix. Priority was given to studies conducted in Pakistan. Where evidence from Pakistan was lacking, studies from countries with similar socio-cultural and economic context were included; if these were unavailable, relevant findings from studies from other settings were included. To help readers assess transferability, the geographical setting of each cited study is documented in Table 2. Moreover, the findings which are populated based on the reported literature from Pakistan have been explicitly documented in results and referenced in bold letters in the Table 2.

Around 11% of the total cited articles were from Pakistan (7/61). The findings from other settings were contextualized and translated for Pakistan's context through a structured review by the implementation team and subsequent expert validation (described below). Furthermore, contextualized explanation of the findings was also formulated through the aforementioned steps.

Implementation team insights

Findings from the literature were reviewed collaboratively with the implementation team to help contextualize the evidence and identify areas where local experiences could add nuance or clarify gaps. These on-the-ground insights were incorporated to enhance the matrix's contextual relevance and practical grounding.

Expert validation and refinement

The draft matrix and literature review findings were validated and enriched through a participatory consultation with seven local subject matter experts in gender, equity, public health, and healthcare. Participants were purposively selected for their expertise and familiarity with the local context, and represented a diversity of perspectives: senior public health professionals, academics in Gender Studies and Anthropology, a gender focal person at ministry level, a gender expert from the development sector with substantial experience designing and implementing equity-focused programmes, a community leader with extensive experience in transgender-focused development initiatives, and an infectious disease specialist.

Experts received briefing packs in advance outlining the project, consultation objectives, and a copy of the draft populated matrix. The consultation was participatory and combined facilitated discussion with opportunities for written feedback, ensuring input on the structure (topic-specific domains along with biological and social stratifiers) and the populated findings in the matrix. Detailed notes were taken during the session by two research team members, particularly highlighting the difference in inputs from different experts on the findings in the populated matrix. Separate iterative online discussions were conducted only with the experts having difference in inputs by seeking clarifications to improve understanding until a shared perspective was agreed upon (Arakawa and Bader 2022).

All substantive input was integrated into the populated matrix, enhancing its clarity, accessibility, and cultural resonance.

Table 2 Populated gender and equity matrix in rural Pakistan.

	Topic-specific domains		
	Susceptibility/vulnerability to infection	**Care provision (during facility visit)**	**Care uptake (before and after facility visit)**
Biological and social stratifiers			
Sex	(Cisgender) women more prone to infections; higher antibiotic prescribing (Maher 2013)	—	—
Age	Elderly and children face higher risk of severe disease (El Chakhtoura et al. 2017, Korppi et al. 2022)	Providers reluctant to take 'risk' of not prescribing antibiotics to elderly/children (Hayward et al. 2019, Abdel-Aty et al. 2024) (UK, Egypt); under-confidence in diagnosing and treating disease conditions in elderly and children (Hamre et al. 2014, Masot et al. 2022) (multicountry[a]); communication challenges for providers with elderly and young women*; symptoms less reliable in elderly and children (Skinner et al. 2016) (Quitadamo et al. 2014) (multicountry[a]); comorbidity in elderly can complicate antibiotic prescribing (Beckett et al. 2015, Dylis et al. 2019, Alves et al. 2024) (multicountry[a]); male physicians' tendency to avoid detailed examination of younger women with general illness**	Access/adherence in elderly shaped by physical ability, financial means, and family support (Mohd Rosnu et al. 2022) (South East Asia); elderly and children have low tolerance for slow clinical response → which can lead to switching to alternate care sources*; self-medication patterns across different age groups varies in different settings (Saha et al. 2022, Morgan et al. 2023, Rafati et al. 2023) (multicountry LMIC); polypharmacy challenges in elderly (Soraci et al. 2023) (multicountry[a]); comorbidities affect minor ailment care-seeking in elderly*; younger patients are more able to access online disease and care information (Heponiemi et al. 2022) (Finland)
Education level	Education influences hygiene practices linked to prevent transmission of infections (Akter and Ali 2014) (Bangladesh)	Doctor and allied staff on-job training improves care*; more cautious prescribing with literate patients because of improved understanding (Sarwar et al. 2018a, 2018b) (**Pakistan**); communication reported to be easier with educated patients*; there is perception that educated patients are better able to report/explain symptoms and enquire/better understand their illness and advised care*	Education is linked to timely care-seeking (Lam et al. 2013, Sabbir Ahmed and Yunus 2020, Li et al. 2024) (multicountry LMIC), appropriate provider choice (Ogunlesi and Olanrewaju 2010, Inche Zainal Abidin et al. 2014, Adinan et al. 2017) (Nigeria, Tanzania, and Malaysia), responsible antibiotic use (Mallah et al. 2022) (multicountry[a]), appropriate response to disease deterioration and/or drug side effects**; better access to online knowledge and care (Tieu et al. 2015) (USA)
Marital status	—	Providers report easier examination/communication with married women*; more inclined to prescribe antibiotics to married women because of perceived limited access to health facility**	Higher self-medication among married women (Almaqhawi et al. 2023) (Saudi Arabia); adherence affected by domestic responsibilities**; women (married/unmarried) dependent on family resources and approval for seeking care (Rizvi Jafree and Barlow 2023) (**Pakistan**)

(*continued*)

Table 2 Continued

	Topic-specific domains		
	Susceptibility/vulnerability to infection	**Care provision (during facility visit)**	**Care uptake (before and after facility visit)**
Occupation	Certain occupations increase infection and impede ability to prevent transmission risk (Acke et al. 2022, Biswas et al. 2024) (multicountry[a])	Care providers' behaviour may vary across occupational background regarding assessment and prescribing (Chapman et al. 2013, Job et al. 2024) (multicountry[a])	Daily wage workers face higher opportunity cost seeking care during work hours (Jacob et al. 2014, Maryam et al. 2018, Hasan et al. 2021) (multicountry LMIC); daily wage workers prefer quick relief* and have lower follow-up adherence (Sharma et al. 2017) (India); farm workers may show seasonal care-seeking variation pattern*
Residence—size/ownership	Small/inadequate housing increases transmission risk (Aldridge et al. 2021, Islam et al. 2021, Leece et al. 2023) (multicountry[a])	Care providers' biomedical focus can constrain their attention to social determinants of health affecting patients' outcomes (Brochier et al. 2020, Iott et al. 2022, Mizumoto et al. 2023) (multicountry[a])	Individuals with lower quality housing are less able to adhere to prevention measures (Bhandari et al. 2015, Khan and Fang 2021, Al Masud et al. 2025) (Bangladesh, **Pakistan**, and India)
Physical and social disadvantage	Stigma/disability increase vulnerability and affect care-adherence (Molton et al. 2014, Elvis and Prosper 2015, De Beaudrap et al. 2017, Brand et al. 2022) (multicountry[a])	Physicians find challenging to communicate with people with physical/social disabilities (Agaronnik et al. 2019) (USA)	Physical/social disabilities may affect individual ability to visit facility (Lee et al. 2021, McBride-Henry et al. 2023) (multicountry[a]); cognitive/speech disabilities may hamper provider–patient communication (Stransky et al. 2018) (Netherlands, USA)
Gender analysis domains			
Access to healthcare and resources	Malnutrition is more common among women and reduces the ability to fight infections**; limited WASH[b] access and infrastructure for women contributes to poor infection prevention and control**; minority genders face transmission risk (group living)** and social challenges to access healthcare (discrimination, stigma) (Ahmad et al. 2024) (**Pakistan**)	Patient–provider difference in gender was not seen as affecting access to primary facilities for general illnesses such as URTI/diarrhoea*; male physicians' tendency to avoid detailed examination in females*; health staff (doctors and allied health professionals) pay less attention to counselling women for responsible consumption of drugs**	Individual preference to seek care from same-gender physicians (Fink et al. 2020) (USA); Women's ability to access healthcare depends on her marital status, family financial and social assistance and/or endorsement, healthcare setting and staff behaviour, access to mobile/internet (Rizvi Jafree and Barlow 2023) (**Pakistan**); males are likely to get priority for healthcare spending**
Distribution of labour, practices, and roles	Women handle food more leading to a higher risk of exposure to and transmission of infections**; Pakistani domestic workers are predominantly female and often face a higher risk of acquiring infections due to their working and living conditions**	Male-dominated health workforce (doctors and allied staff) highlighting additional considerations for women community in care seeking and utilization*; physicians perceive higher risk of women patient attrition → higher inclination for prescribing antibiotics (Singer et al. 2018) (Canada); women often describe symptoms in greater detail—unclear prescribing link**	Women in underprivileged areas prioritise household/family needs over personal health (Habib et al. 2021) (**Pakistan**); women receive less family support for care adherence/responsible drug consumption (Habib et al. 2021) (**Pakistan**)

(*continued*)

Table 2 Continued

	Topic-specific domains		
	Susceptibility/vulnerability to infection	**Care provision (during facility visit)**	**Care uptake (before and after facility visit)**
Norms, values, beliefs	Mild/early-stage illnesses in women more likely to be overlooked → leading to a progression risk**; women culturally expected to nurse sick family members → higher exposure risk**	Provider's cultural sensitivity improves care*; improved care experience when privacy valued during examination (Thomas and Brigit 2018, Pratiwi et al. 2022) (India, Indonesia); physicians pay more attention to accompanying male while communicating with women—can be linked with higher perceived education of male attendants*	Perceived access/quality of care affect uptake (Gabrani et al. 2020, Nwokoro et al. 2022) (Albania, Nigeria); low literacy among women hinders them from challenging misconceptions**; cultural norms limit women's independent mobility**; men more prone to antibiotic self-medication (Aslam et al. 2022) (**Pakistan**)
Decision-making power and autonomy	Limited decision-making power delays women's care, worsens health outcomes (Idris et al. 2023) (multicountry[a])	Health staff feel compelled to convince women patients' families to accept advised care*	Women are more likely to: seek care from unregulated or lay providers (Onuegbu et al. 2021, Arjyal et al. 2023) (multicountry LMIC); require family approval for care**; need additional counselling to comply with the advised care (in her respective household setting)**
Policies, laws, and institutions	Weak institutional arrangements (no formal and supportive mechanisms) limit women's ability to claim patient rights**	Absence of health facility policy guidance for gender-sensitive amenities (seating, drinking/washroom, etc.); increased risk of staff ignorance*	Lack of community-level forums for women to share healthcare experiences and report challenges**

*Inputs from implementation professionals of authors' organization; **Inputs from expert validation and refinement session; [a]Only multicountry implies that evidence was from different countries across the globe; [b]Water, sanitation, and hygiene.

The revised version was recirculated to all participants for review and approval before proceeding to the thematic synthesis stage.

A duly completed Consolidated criteria for Reporting Qualitative Studies checklist for the expert validation and refinement session is attached as Supplementary File 1.

Thematic synthesis

The final stage involved synthesizing the populated matrix to identify patterns that cut across topic-specific domains, stratifiers, and gender analysis domains. Because the matrix structure inherently organizes evidence into pre-specified categories, the synthesis process focused on reviewing these entries in relation to each other, grouping related observations, and integrating insights into broader analytical themes. This approach, adapted from thematic synthesis principles described by Thomas and Harden (2008), enabled us to move beyond descriptive categorization to make visible the mechanisms—often implicit in the literature and field insights (Naeem et al. 2023)—through which inequities shape antimicrobial resistance risks.

Results

Although the topic domains in the gender and equity matrix grouped care provision and care uptake into two domains, the thematic synthesis revealed that inequities across the care continuum manifested in three analytically distinct stages: (1) access and utilization, (2) treatment/prescribing interactions, and (3) adherence and follow-up. We therefore report findings across four interconnected domains—retaining susceptibility/vulnerability and care provision, previously defined as the topic-specific domains and disaggregating care uptake into access and utilization of care along with treatment adherence and follow-up—to more clearly reflect how gender and social stratifiers operate at each point of care.

The findings described below have been contextualized for Pakistan through a multistage qualitative review and refinement process outlined in the methods section. Additionally, if the findings are based on the published literature, citations have been included within the results to provide readers with clearer insight into the origins of findings that were derived from existing literature. The populated GE matrix is provided in Table 2.

Susceptibility/vulnerability to infection

Gendered inequalities in nutrition, roles, and living conditions contribute to women's greater susceptibility to infection and severity of outcomes. In Pakistan, women have high malnutrition,

because of overall limited access to nutrient-rich food items and gender-biased food allocation practices within households; men and boys are often prioritized for larger or more nutritious portions, weakening women's immune resilience and increasing infection risk. Women's limited access to safe water, sanitation, and hygiene (WASH) facilities further undermines infection prevention, as inadequate toilets, handwashing facilities, and clean water supplies increase everyday exposure to pathogens. Moreover, the absence of gender-segregated WASH facilities, combined with cultural barriers that discourage women from using shared toilets except when absolutely necessary, increases their risk of infections. Our findings also report vulnerabilities for transgender and gender-diverse people in Pakistan's context. The community stigma and discrimination (Ahmad et al. 2024), combined with limited financial resources, often force this population into communal living arrangements. This amplifies infection risk due to factors such as overcrowding, poor ventilation, and restricted access to preventive measures that could reduce transmission.

Household and occupational roles also shape exposure. In Pakistan, women's domestic responsibilities, particularly food preparation and caregiving for sick family members, increase their risk of exposure to pathogens and the likelihood of onward transmission. Because these roles involve direct contact with contaminated food, water, or family members with infectious illnesses, they heighten both vulnerability to infection and potential for spread within households. In rural areas, women from low socioeconomic background frequently work as domestic workers. These jobs expose them to unhygienic conditions on routine basis with very limited control over their environment. Combined with their poor home living conditions (smaller or inadequate housing in low income rural conditions constraints the ability to practice infection prevention), their risk of infection is amplified significantly as reported by literature from Pakistan and elsewhere (Bhandari et al. 2015, Khan and Fang 2021, Al Masud et al. 2025).

Vulnerability to infections was also found to be related to different biological stratifiers. For instance, in Pakistan, children and elderly populations are recognized as more vulnerable to severe disease, while comparative evidence shows similar patterns globally (El Chakhtoura et al. 2017, Korppi et al. 2022).

Certain occupations such as agricultural/farm workers and daily wage labourers are more exposed to infection risks (Acke et al. 2022, Biswas et al. 2024) through crowded and unhygienic work conditions, contact with animals or waste, irregular working hours, and a lack of occupational safety equipment/gear. Among farm workers, seasonal fluctuations in workload and environmental exposure increase susceptibility to infection and can disrupt opportunities to seek timely care.

Access to and utilization of care

Access to healthcare in Pakistan is strongly shaped by gendered norms, household decision-making arrangements, and socioeconomic stratifiers. Literature from Pakistan reports that women often require permission or financial support from male relatives/households before seeking care (Rizvi Jafree and Barlow 2023) or prioritize household responsibilities over their health (Habib et al. 2021) leading to delayed treatment and worsening outcomes. These delays mean infections may progress to more severe stages, increasing the likelihood of more intensive antibiotic use. In rural areas, cultural norms restricting women's independent mobility create further barriers to reaching facilities. By contrast, men are more likely to be prioritized for household health expenditures, ensuring quicker access to formal care.

Socioeconomic stratifiers also mediate access. In Pakistan, literate patients are more likely to seek timely care, understand providers' advice, and choose appropriate providers. Women with low literacy, however, require additional support for adequate care seeking and adherence. Comparative evidence from other countries reinforces that education facilitates timely and appropriate care-seeking (Ogunlesi and Olanrewaju 2010, Lam et al. 2013, Inche Zainal Abidin et al. 2014, Adinan et al. 2017, Sabbir Ahmed and Yunus 2020, Li et al. 2024). Occupational status adds additional barriers: daily wage workers often avoid visiting facilities during work hours because of lost income (Jacob et al. 2014, Maryam et al. 2018, Hasan et al. 2021). Those who do attend may demand rapid treatment to minimize time away from work—frequently in the form of antibiotics, even when not clinically indicated. The economic pressure to return to work may push patients towards antibiotics as a perceived 'quick fix'. In some cases, when care is delayed or unaffordable, households substitute prescribed treatment with leftover drugs, prefer traditional remedies, or seek care from unregulated providers which risks incomplete or inappropriate antibiotic use.

Together, these dynamics show that in Pakistan, as elsewhere, gender norms and socioeconomic stratifiers determine who can seek care, when, and from whom. Limited and delayed access among women, poorer households, and daily wage workers not only worsens health outcomes but also contributes to inappropriate antibiotic use, including reliance on unregulated or informal sources, which increases risk of resistance. Once patients reach facilities, these same inequities continue to shape clinical interactions and prescribing practices.

Clinical interaction and prescribing practices

Clinical interactions in Pakistan are shaped by provider perceptions and gendered social norms, with significant implications for prescribing practices. Male physicians have been found to avoid detailed examinations of unmarried women, reflecting modesty norms, and often defer communication to accompanying male relatives because of their perceived relevance in decision-making. This undermines women's autonomy and quality of care. These practices also limit women's ability to describe symptoms fully and receive accurate diagnoses, which can push providers towards unnecessary antibiotic prescribing as a precaution, thereby increasing the risk of resistance. Married women may also receive antibiotics more readily, reflecting provider assumptions that their household caregiving responsibilities make illness more disruptive and that they have less autonomy to return for follow-up care.

Provider caution also varies by age. In Pakistan, physicians are reluctant to withhold antibiotics from elderly patients and children, perceiving them as higher risk, even when symptoms do

not justify prescribing (Hayward et al. 2019, Abdel-Aty et al. 2024). From the provider perspective, diagnostic uncertainty in cases of elderly and children (owing to inadequate explanation of symptoms)—including limited confidence in recognizing atypical symptoms and concern about rapid deterioration—can prompt 'safety net' antibiotic prescribing, where antibiotics are given 'just in case' to guard against complications. This practice, while intended as protective, fuels unnecessary antimicrobial use and resistance. International studies echo this tendency towards precautionary prescribing (Hamre et al. 2014, Masot et al. 2022). Comorbidities among older adults further complicate diagnostic decision-making (Beckett et al. 2015, Dylis et al. 2019, Alves et al. 2024).

Educational stratification influences prescribing behaviour. Evidence from Pakistan suggests that providers are more cautious when treating literate patients, who are seen as better at describing symptoms and understanding care instructions (Sarwar et al. 2018a). By contrast, patients with low literacy may be perceived as less reliable narrators of illness, increasing the likelihood of unnecessary prescribing.

Patients with physical, sensory, or cognitive disabilities face access and communication challenges with providers, limiting their ability to convey symptoms and sometimes leading to less tailored treatment decisions. This pattern is consistent with international literature (Agaronnik et al. 2019).

Overall, these findings show that in Pakistan, as in other settings, provider perceptions of patient gender, age, literacy, disability, and social position strongly influence prescribing behaviour. These perceptions often lead to precautionary or unnecessary antibiotic use, undermining stewardship goals and affecting the likelihood of treatment adherence and follow-up.

Treatment adherence and follow-up

Treatment adherence and follow-up in Pakistan are strongly influenced by gender roles, responsibilities, and socioeconomic conditions. Literature reported from Pakistan suggests that women's domestic duties frequently compete with personal health needs, leading to interruptions in treatment schedules or missed follow-up visits. Household responsibilities—such as childcare, cooking, and managing other family members' health—often take precedence, leaving little time for women to prioritize their own health, which disrupts adherence (Habib et al. 2021). At the same time, men in Pakistan are more likely to self-medicate with antibiotics, bypassing provider guidance and increasing risks of misuse (Aslam et al. 2022). This is because of the limited understanding, influence of cultural norms, and limited perceived priority for health. Self-medication is aggravated by over-the-counter access to antibiotics, cultural norms, and limited literacy. These factors encourage self-reliance and may lead to inappropriate drug choice, incorrect dosing, or incomplete courses—all of which accelerate antimicrobial resistance.

Age stratification adds further barriers. In Pakistan, elderly patients struggle with adherence due to limited mobility, comorbidities, polypharmacy (the concurrent use of multiple medications), and reliance on family support. Children's adherence depends entirely on caregiver support, making parental attention and resources decisive. Comparative evidence highlights similar age-related challenges elsewhere (Mohd Rosnu et al. 2022, Saha et al. 2022, Morgan et al. 2023, Rafati et al. 2023, Soraci et al. 2023).

Occupation also influences adherence. Daily wage workers often discontinue treatment early because of the economic pressure to return to work and avoid further income loss. This pressure can lead them to stop medication once symptoms improve, skip follow-up visits, or purchase incomplete prescribed course, resulting in incomplete treatment and heightened risk of resistance.

In Pakistan, literate patients are better able to follow treatment instructions, recognize side effects, and seek appropriate follow-up. Less educated patients, particularly women, are more vulnerable to misinformation and nonadherence, in part because they may be more dependent on others for interpreting prescriptions and making health decisions. Housing and stigma also undermine adherence: poor living conditions can make it harder to store medicines safely or maintain hygiene, while social disadvantage and discrimination reduce individuals' willingness or ability to return for follow-up (Bhandari et al. 2015, Elvis and Prosper 2015, De Beaudrap et al. 2017, Khan and Fang 2021, Brand et al. 2022, Al Masud et al. 2025).

Taken together, these findings illustrate that in Pakistan, overlapping inequities linked to gender roles, literacy, occupation, and age shape antibiotic adherence and follow-up. Nonadherence among women with competing responsibilities, men who self-medicate, elderly patients with mobility or comorbidity constraints, and disadvantaged groups underscores the need for gender- and equity-responsive stewardship strategies across the care continuum.

Discussion

This study applied a gender and equity matrix to synthesize evidence on how social and structural inequities shape antibiotic prescription and use in rural Pakistan. By layering gender analysis domains with topic-specific domains, the matrix illuminated how inequities accumulate across the care continuum. The adapted matrix proved useful for tracing how inequities interact across different stages of care, rather than being confined to a single stratifier or point in the system. This demonstrates that antimicrobial resistance in Pakistan is not only a biomedical or behavioural challenge, but also one deeply rooted in social justice concerns.

Our analysis demonstrates that antibiotic use in rural Pakistan is shaped both by individual medical needs alongside overlapping inequities in gender roles, literacy, occupational status, disability, and age. These inequities interact with structural conditions—such as inadequate WASH facilities, restrictive mobility norms, and under-resourced health facilities—to both increase infection risk and constrain appropriate antibiotic use. For instance, women's caregiving responsibilities and limited mobility delay their access to treatment, while daily wage workers often postpone care to avoid income loss. In provider–patient interactions, social markers such as literacy function as forms of legitimacy, influencing diagnostic confidence, communication, and prescribing. Patients perceived as literate may receive more detailed attention, while those with limited education—

often women, labourers, or people with disabilities—risk being side-lined in treatment decisions. Such patterns are consistent with global evidence suggesting that AMR mitigation strategies should give adequate attention to sociocultural and structural contexts (Ayukekbong et al. 2017). However, these dynamics are especially acute in Pakistan, where gender norms and poverty intersect to produce marked disparities in access to and quality of care.

Findings from the matrix underscored how deeply embedded community norms influence not only the care delivery of marginalized groups, particularly women and minority genders individuals but also affect broader patterns of care-seeking and treatment adherence. Moreover, the influence of these community norms extends well beyond gender and intersects with multiple social and biological stratifiers as revealed by global literature (Alison et al. 2025). Our study found that age plays a significant role, as elderly and children are often culturally perceived as more susceptible to severe diseases, resulting in their lower tolerance for slow clinical recovery and a tendency to seek alternate sources of help or self-medicate. Poor living conditions were identified as a key risk factor, heightening vulnerability to disease by restricting people's ability to maintain hygiene and follow infection prevention practices. A unique contextual finding concerns communal living among transgender women and 'Khawaja siras', a long-recognized gender-diverse community in South Asia (Iqrar et al. 2023). While these communal households provide safety and solidarity, they are often overcrowded and poorly ventilated, making timely infection prevention and isolation difficult. Social disadvantage and stigma further influence access to health facilities. These findings align with global evidence (Adebisi and Ogunkola 2023, Gautron et al. 2023, Adebisi 2024) and underscore the need for people-centred AMR mitigation strategies that ensure that no one is left behind in achieving optimal care (World Health Organization 2023, Jesudason 2024).

Published evidence suggests that intersectionality is an effective approach for examining equity gaps in healthcare, as it helps uncover the underlying mechanisms and processes embedded within sociocultural structures, which are not directly visible (Tinner et al. 2023, Vohra-Gupta et al. 2023). Through application of this approach, our study shows that equity gaps widen across the care continuum within rural Pakistan, as early barriers to access are compounded by biases in provision and by adherence challenges shaped by household roles and economic insecurity. Responsive AMR interventions must therefore adopt an equity lens across all stages of care—from community-level barriers to care provision activities and follow-up (Marcelin et al. 2024).

The widening of equity gap based on the intersectionality lens also suggests that poor antimicrobial stewardship outcomes (such as over-prescribing, poor adherence, lay-care, inadequate examination) are more likely to influence disadvantaged sections of communities. It implies that antimicrobial stewardship efforts in Pakistan cannot focus only on prescribers but must also tackle the community and household-level inequities that shape who seeks care, when, and how. This requires adapting a community-led model; going beyond the health system building blocks and integrating local communities as key actor as well as beneficiaries for healthcare services (Sacks et al. 2019).

Analytical contribution of the gender and equity matrix

This study demonstrates that the gender and equity matrix is more than a classification tool—it surfaces the interactions between social roles, provider behaviour, and structural constraints that contribute to AMR risks in rural health systems. Without this intersectional mapping, these patterns remain fragmented across literature and policy dialogues, limiting the design of targeted, equity-responsive AMR interventions. The matrix can be adapted for other LMIC contexts, providing a replicable framework for incorporating gender and social determinants into AMR research, surveillance, and programme planning. Its flexible structure allows it to be populated with both published evidence and empirically generated insights, making it feasible to apply in data-constrained environments if findings are validated by relevant experts. A recent publication (published after matrix was formulated) validated one of the findings from our expert validation and refinement session (Naz et al. 2025).

In our case, the matrix also directly informed the ongoing stewardship intervention by (1) integrating data collection on relevant biological and social stratifiers into routine monitoring and guiding its analysis; (2) informing tool development for process evaluation; (3) shaping a gender and equity sensitization package for healthcare staff at RHCs; (4) improving gender and equity responsiveness of health facilities; and (5) informing the content of educational messages for patients and families in the digital application. These applications illustrate the dual value of the matrix as both an analytical and practical tool for designing equity-responsive AMR interventions.

Limitations and future research opportunities

While the matrix draws on both published evidence and expert consultation, important gaps remain in understanding how AMR risks manifest, particularly among minority genders and people with disabilities. Cross-context evidence was necessary to address some of these gaps but must be interpreted with caution given contextual variations in social norms, structural conditions, and health system organization. Furthermore, while the findings are centred on Punjab, many elements are likely to be similar across other provinces, though some contextual caution remains appropriate.

These limitations highlight several priorities for future research, including; (1) in-depth qualitative studies with under-represented groups to examine how intersecting forms of exclusion affect infection risk, care access, and antibiotic use; (2) facility-level research linking antibiotic prescribing patterns to diagnostic capacity, provider–patient dynamics, and structural constraints; and (3) implementation research evaluating gender- and equity-responsive AMR interventions that address both provider practices and patient care-seeking or adherence in rural LMIC contexts.

Conclusion

This study applied an adapted gender and equity matrix to show how gender norms, social stratifiers, and structural conditions

shape antibiotic prescription and use in rural Pakistan. Inequities in mobility, decision-making power, provider–patient communication, and economic security accumulate across the care continuum, discouraging timely care-seeking and undermining treatment adherence.

The analysis shows how the gender and equity matrix can be used not only to classify inequities but also to reveal the mechanisms through which social and structural drivers interact to influence AMR risks. In Pakistan, where stewardship guidelines are not gender and equity responsive at primary care level, these findings offer actionable entry points for integrating gender and equity considerations into emerging policies and programmes. More broadly, the matrix can be adapted in other LMIC contexts to strengthen AMR surveillance, research, and health system responses, ensuring interventions are not only clinically effective but also socially inclusive and equitable.

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Author contributions

Conception or design of work: S.A.K., A.K., M.A.K., N.K., F.Z., I.L. Data collection: S.A.K., A.K., S.E.K., F.Z. Data analysis and interpretation: S.A.K., I.L., A.K., C.V.-G., E.W., A.K., R.M., M.A.K., S.E.K. Drafting the article: S.A.K., I.L., A.K., N.K. Critical revision: I.L., M.A.K., A.K., R.M., E.W., C.V.-G., N.K. All authors have approved manuscript and their contributorship.

Supplementary material

Supplementary material is available at *Health Policy and Planning* online.

Conflicts of interest

The authors report no financial or personal conflicts of interest that could have influenced the work reported in this manuscript.

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Ethical approval

Ethical approval was not sought, as the work was limited to expert engagement and review of existing published evidence, with no sensitive primary data collection from human participants.

Reflexivity statement

Our team comprises local and international public health professionals, gender, equity, and antimicrobial resistance experts. Seven of the total authors are females and rest are male. We acknowledge that our backgrounds may have influenced the framing and interpretation of the findings.

Data availability

All the relevant data has been published as part of the gender equity matrix in the article (Table 2). For more details on the raw information, please feel free to contact the corresponding author.

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