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Pharmacology And Public Health: Strategies For The Safe And Effective Use Of Medications

Renata Ferreira Diogo, Maria Carolina Barreto De Oliveira Sousa, Alanna Nascimento Delgado Mota, Flávio Ricardo Silva Sousa, Alzira Regina Dantas Dias, Gabriel Mota Paiva, Thayse Maciel Sá, Vanderson Ramos Mafra, Vera Lúcia Cavalcante Rodrigues, Maykon Jhuly Martins De Paiva

[1] *Faculdade Anhanguera De Imperatriz, Imperatriz, Maranhão, Brazil*
[2] *Faculdade De Imperatriz -Facimp, Imperatriz, Maranhão, Brazil*
[3] *Universidade De Gurupi – Unirg, Paraíso Do Tocantins, Tocantins, Brazil*
[4] *Universidade Federal Do Tocantins – UFT, Palmas, Tocantins, Brazil*
[3] *Universidade De Gurupi – Unirg,Gurupi, Tocantins, Brazil*

Abstract:
Background: *The rational use of medicines is a global health priority. Pharmacology, as a scientific foundation for drug development and clinical application, plays a pivotal role in promoting safe and effective pharmacotherapy. In the context of public health, this involves not only individual prescribing, but also strategic policies, education, and surveillance systems aimed at optimizing therapeutic outcomes and reducing medication-related harm.*
Materials and Methods: *This is a narrative review based on scientific literature, institutional reports, and public health guidelines, focusing on pharmacological strategies aligned with public health goals, including rational drug use, pharmacovigilance, access to essential medicines, and health education.*
Results: *Key strategies identified include the implementation of essential medicines lists, strengthening pharmacovigilance systems, promoting pharmaceutical care models in primary health, and expanding the role of pharmacists in public health initiatives.*
Conclusion: *Integrating pharmacological knowledge with public health actions is essential to ensure safe, effective, and equitable use of medications, contributing to better population health outcomes.*
Key Word: *Pharmacology; Public Health; Rational Drug Use; Pharmacovigilance; Pharmaceutical Policy.*
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I. Introduction

Access to safe, effective, and affordable medications is a fundamental pillar of health systems and a central component of the right to health. As pharmacology evolves through advances in drug discovery, pharmacogenomics, and clinical therapeutics, it becomes increasingly important to align this knowledge with the principles of public health. The misuse, overuse, and underuse of medications continue to be significant contributors to avoidable morbidity and mortality worldwide, particularly in low- and middle-income countries where health systems face structural challenges [1,2]. The World Health Organization (WHO) has repeatedly emphasized the need for comprehensive strategies to ensure the rational use of medicines, considering not only their pharmacodynamic properties but also socioeconomic and cultural contexts that influence prescribing and adherence [3,4].

Pharmacology, as the science that elucidates how drugs interact with biological systems, serves as a critical foundation for ensuring therapeutic efficacy and minimizing harm. However, without integration into broader public health frameworks, even the most scientifically advanced pharmacological interventions may fall short in achieving their intended population-level outcomes. Medication errors, adverse drug reactions (ADRs), therapeutic duplication, and irrational combinations remain frequent in both hospital and outpatient settings [5]. These issues are often exacerbated by gaps in professional training, limited access to updated clinical guidelines, and insufficient patient education.

In the public health context, pharmacology extends beyond the molecular mechanisms of action to include the dynamics of drug use in populations. This includes ensuring equitable access through essential medicines policies, monitoring outcomes through pharmacovigilance systems, and promoting medication adherence via educational and behavioral interventions [6]. Pharmacists and other healthcare professionals play a

strategic role in this process, acting not only as dispensers of medications but as educators, caregivers, and public health advocates. Their actions directly impact the success of health programs aimed at controlling chronic diseases, preventing antimicrobial resistance, and reducing hospitalizations related to medication misuse [7].

Furthermore, the global trend toward health system universalization and the increasing burden of chronic diseases demand innovative and integrated approaches to pharmacological care. Public health-oriented pharmacology must be grounded in evidence-based protocols, supported by digital technologies (such as e-prescribing systems and mobile health apps), and driven by interprofessional collaboration. Strategic investment in training, surveillance infrastructure, and access programs is essential to guarantee the safe and rational use of medications. Special attention must also be given to vulnerable populations, such as the elderly, children, pregnant women, and individuals with multiple comorbidities, whose pharmacotherapeutic management requires individualized and cautious approaches [8,9].

This article aims to analyze the interface between pharmacology and public health, highlighting strategies that promote the safe and effective use of medications. It explores the principles of rational drug use, the role of pharmacovigilance, the importance of access policies and essential medicines lists, and the contribution of pharmaceutical care in primary health settings. By proposing an integrative model based on scientific evidence and public health policies, this work contributes to strengthening the governance of pharmacotherapy in health systems and improving population health outcomes.

II. Material And Methods

This work consists of a narrative integrative review, developed with the objective of synthesizing scientific knowledge and institutional guidelines related to the safe and effective use of medications from a public health perspective. The integrative review method was chosen for its capacity to incorporate diverse types of evidence — from experimental research and observational studies to official documents and public policy reports — thus enabling a comprehensive understanding of the intersection between pharmacology and collective health strategies.

The bibliographic survey was conducted between January and April 2025, using the electronic databases PubMed, Scopus, Web of Science, SciELO, and the World Health Organization (WHO) document repository. The following search terms (descriptors and keywords) were used in English and Portuguese: “pharmacology”, “public health”, “rational use of medicines”, “pharmaceutical policy”, “pharmacovigilance”, “medication safety”, “essential medicines”, and “primary health care”. Boolean operators (AND/OR) were applied to refine the search and maximize relevance.

Inclusion criteria considered articles and documents published between 2010 and 2024, available in full text, written in English, Portuguese, or Spanish, and that addressed at least one of the following axes: pharmacological strategies in public health, pharmaceutical care models, policies for access to essential medicines, or health education related to drug use. Exclusion criteria included studies with methodological flaws, duplicate publications, and works that did not address medication use within a population or systemic context.

The analysis and synthesis of the findings followed a categorical thematic approach, allowing the identification of strategic axes for the safe and effective use of medications: (1) Rational Drug Use (RDU); (2) Pharmacovigilance; (3) Access to Essential Medicines; (4) Pharmaceutical Care in Primary Health Care; and (5) Education and Communication in Health. Each axis was discussed from both a pharmacological and public health perspective, highlighting integrated strategies and their real or potential impacts.

Additionally, international and national health documents were analyzed — including reports from the WHO, Pan American Health Organization (PAHO), Brazilian Ministry of Health (such as the National Policy on Pharmaceutical Services and the National List of Essential Medicines - RENAME) — to contextualize the applicability of scientific evidence in health policies. This approach reinforces the translational nature of the study, aiming to bridge the gap between academic knowledge and practical actions in health systems.

III. Result

The results of this integrative review are presented according to five thematic axes that represent the core strategies for improving the use of medications in public health contexts. Each axis combines evidence from pharmacological science with public health interventions aimed at reducing medication-related harm and promoting therapeutic effectiveness.

1. Rational Use of Medicines (RUM)

The rational use of medicines (RUM) is a central pillar in ensuring pharmacotherapeutic success and minimizing risks. Evidence indicates that over 50% of medicines are prescribed or used inappropriately worldwide (10). Strategies to address this include the development and implementation of clinical protocols, treatment guidelines based on scientific evidence, and continuing professional development programs for prescribers. National programs such as Brazil's *National Policy for Pharmaceutical Services* have demonstrated that when

standardization of prescribing practices is supported by training and supervision, significant improvements in prescription quality and therapeutic outcomes are achieved (11,12).

2. Pharmacovigilance and Medication Safety

Pharmacovigilance systems play a vital role in detecting, assessing, understanding, and preventing adverse effects or any other drug-related problems. The expansion of digital tools like VigiFlow and VigiMed has facilitated reporting and risk communication globally (13). Countries that invest in post-marketing surveillance and spontaneous adverse drug reaction (ADR) reporting tend to experience fewer preventable hospitalizations related to medications. Studies show that integrating pharmacovigilance with public health surveillance enables better responses to safety signals, especially in campaigns involving mass drug administration or pandemic responses (14).

3. Access to Essential Medicines

Ensuring equitable access to essential and cost-effective medications is fundamental for population health. The WHO Model List of Essential Medicines, adopted by many countries through national adaptations (e.g., RENAME in Brazil), serves as a tool for prioritizing availability in public health systems (15). Access programs such as Farmácia Popular and similar international models (e.g., India's Jan Aushadhi scheme) have increased medication coverage in low-income populations (16). However, logistical failures and lack of financing remain obstacles. Integration with health technology assessment (HTA) and centralized purchasing mechanisms has proven to be a key strategy for sustainability (17).

4. Pharmaceutical Care in Primary Health Systems

The inclusion of pharmacists in primary care teams has shown to reduce medication errors, optimize pharmacotherapy, and improve adherence, particularly among chronic disease patients. Pharmaceutical care services such as medication reconciliation, therapeutic monitoring, and patient counseling enhance clinical outcomes. Evidence from Brazil, Spain, and Canada highlights that pharmacist-led interventions can significantly reduce hospital readmissions and improve quality of life, especially in elderly and polymedicated populations (18,19).

5. Health Education and Digital Tools for Medication Literacy

Health education campaigns aimed at patients and communities contribute to increased medication literacy, better adherence, and reduced risk of misuse. Public health initiatives that involve social communication, printed materials, mobile applications, and pharmacist-patient interaction have been effective in promoting responsible self-medication and adherence (20). Additionally, e-prescription systems and mobile reminders (mHealth) have emerged as promising digital strategies to support proper medication use, particularly in remote or underserved areas (21).

IV. Discussion

The integration of pharmacological knowledge into public health systems is not merely a scientific imperative, but a strategic necessity to reduce medication-related harm and improve therapeutic outcomes on a population level. The thematic axes discussed in this review demonstrate how multidisciplinary and evidence-based approaches can transform the way medications are prescribed, dispensed, monitored, and used across different health care settings.

Rational use of medicines (RUM) continues to be a global challenge, especially in environments where the health system is fragmented, guidelines are poorly implemented, and irrational prescribing is commonplace. Despite international initiatives such as the WHO's "Medicines Use in Primary Care" reports (10), many countries struggle to enforce standardized prescribing due to lack of political commitment, insufficient training, and pressure from pharmaceutical marketing. In this context, educational strategies targeted at prescribers and patients, combined with regulatory mechanisms, remain fundamental for behavioral change (11,12).

Pharmacovigilance, although increasingly structured in many countries, still faces barriers such as underreporting of adverse drug reactions (ADRs), lack of integration with electronic health systems, and insufficient feedback to health professionals. Strengthening national pharmacovigilance programs and linking them with broader public health surveillance systems can improve risk detection and management, especially during health emergencies like pandemics or vaccine campaigns (13,14).

Additionally, proactive pharmacovigilance approaches — including cohort monitoring, targeted spontaneous reporting, and data mining — should be encouraged.

Access to essential medicines, as highlighted in the results, is a cornerstone of universal health coverage. However, access alone is insufficient if not accompanied by quality assurance, affordability, and rational prescribing. Countries that adopt health technology assessment (HTA) in tandem with national essential medicines lists are

better able to balance clinical value and economic sustainability (15–17). Furthermore, innovative purchasing models, such as pooled procurement and regional funds (e.g., PAHO Strategic Fund), have shown promise in reducing costs and improving supply stability.

Pharmaceutical care, especially in primary care settings, has emerged as a valuable strategy to prevent therapeutic failure, reduce hospitalizations, and enhance patient satisfaction. The recognition of pharmacists as active members of multidisciplinary teams marks a paradigm shift in health care delivery. Still, many systems underutilize their clinical potential due to legal, financial, or institutional limitations (18,19). Expansion of pharmaceutical services, particularly in underserved areas, can be a cost-effective solution to chronic disease management.

Lastly, the intersection of health education and digital innovation opens new pathways for improving medication adherence and literacy. Tools such as mobile health apps, SMS reminders, and digital therapeutic platforms have demonstrated efficacy in chronic disease control, especially among young or tech-savvy populations (20,21). However, digital health strategies must be inclusive and adapted to the needs of vulnerable populations with limited digital access, such as the elderly and rural communities.

In summary, the safe and effective use of medications requires a systemic approach that bridges pharmacological knowledge, public health priorities, and user-centered care. Collaborative governance, continuous education, and technological innovation are key to addressing the complex challenges that permeate pharmacotherapy at the collective level.

Figure 1 – Integration Between Pharmacology and Public Health (See figure below).

Fonte: Developed by the authors (2025).

V. Conclusion

The interface between pharmacology and public health represents a strategic frontier in the pursuit of safer, more effective, and equitable healthcare. As demonstrated in this review, promoting the rational use of medications, strengthening pharmacovigilance systems, ensuring access to essential drugs, expanding pharmaceutical care, and investing in health education are key pillars for optimizing pharmacotherapy at the population level.

The convergence of scientific evidence, health policy, and interprofessional practice allows for the development of more resilient and patient-centered healthcare systems. However, achieving these goals requires not only technological and clinical advances, but also political will, sustainable financing, and continuous investment in professional training and public awareness.

Pharmacology cannot remain isolated in laboratories or confined to prescription practices; it must be translated into public health actions that address the real needs of diverse populations. In this sense, the role of pharmacists and other healthcare professionals is fundamental in the design and implementation of strategies that promote safe, effective, and rational medication use.

By reinforcing the integration between pharmacological science and public health systems, it is possible to reduce medication-related harm, improve therapeutic outcomes, and advance the principles of universal access and comprehensive care. This integrative vision contributes not only to clinical effectiveness, but to the strengthening of health equity and the right to health for all.

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