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Review

Pharmacoeconomics and Health Economics in Drug Policy: A Comprehensive Review of Cost-Effectiveness and Budget Impact Analyses

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ABSTRACT

Increasing healthcare expenditures, aging populations, the rising prevalence of chronic diseases, and the emergence of high-cost pharmaceutical innovations have underscored the urgent need for efficient and evidence-based resource allocation in healthcare systems. As a response to these challenges, health economics and pharmacoeconomics have emerged as essential disciplines for informing policy development and clinical decision-making. This review systematically explores the fundamental principles of health economics and pharmacoeconomics, with a focus on evaluating key analytical approaches such as cost-effectiveness, cost-utility, cost-minimization, and budget impact analyses. Drawing on data from the World Health Organization (WHO), the Organisation for Economic Co-operation and Development (OECD), and national health institutions, the study highlights real-world applications and cross-national comparisons of these methods. The findings reveal significant regional differences in the integration of pharmacoeconomic evaluations into drug reimbursement and health technology assessment (HTA) processes. Moreover, the review identifies key challenges in implementation, including disparities in data quality, methodological transparency, and institutional capacity. Ultimately, this analysis demonstrates that pharmacoeconomic evaluations are indispensable for shaping sustainable, equitable, and patient-centered healthcare systems across the globe.

KEYWORDS: Pharmacoeconomics, Health Economics, Cost-Effectiveness Analysis, Budget Impact Analysis, Health Policy

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1. Introduction

In recent decades, healthcare systems across the world have faced increasing financial pressures due to the rising cost of medical services, aging populations, the burden of chronic diseases, and the emergence of high-priced pharmaceutical innovations. These challenges have emphasized the need for more efficient and evidence-based resource allocation. As a result, the disciplines of health economics and pharmacoeconomics have gained prominence as crucial tools in health policy formulation and clinical decision-making [1-3].

Health economics broadly concerns itself with how resources are allocated within healthcare systems and examines the efficiency, effectiveness, value, and behavior in the production and consumption of health and healthcare. It aims to provide systematic insights into how to make optimal choices under the condition of scarcity—a reality faced by all health systems. Within this context, pharmacoeconomics serves as a subfield focusing specifically on the cost and value of pharmaceutical products and services, integrating both economic and clinical outcomes [2-4].

The growing complexity of healthcare, especially in the pharmaceutical domain, has brought forth questions such as: “Which drugs provide the best value for money?” or “Should health systems reimburse expensive therapies with marginal benefits?” To answer these questions, pharmacoeconomic evaluations utilize a set of comparative methodologies that assess not only the cost of medical interventions but also the outcomes they produce. These include Cost-Minimization Analysis (CMA), Cost-Effectiveness Analysis (CEA), Cost-Utility Analysis (CUA), and Cost-Benefit Analysis (CBA). When used appropriately, these methods offer evidence-based guidance on how best to allocate healthcare spending to achieve the maximum possible health gains [2, 5,6].

Moreover, budget impact analysis (BIA) has emerged as another essential tool, particularly relevant to policymakers and reimbursement agencies. It provides insight into the financial implications of adopting a new drug or therapy within a defined population over a

specified period. Unlike cost-effectiveness studies, which focus on efficiency, budget impact models address affordability—another critical constraint in real-world healthcare systems [7,8].

At the global level, institutions such as the World Health Organization (WHO), Organisation for Economic Co-operation and Development (OECD), and national agencies like the National Institute for Health and Care Excellence (NICE, UK) and Social Security Institution (SGK, Turkey) have increasingly integrated pharmacoeconomic data into reimbursement frameworks. As healthcare budgets tighten and technological advances accelerate, the role of pharmacoeconomic evaluations is no longer optional but imperative [9].

Pharmacoeconomic data play an important role in determining health policies in many countries. In countries such as Australia, Canada, Belgium and Austria, cost-effectiveness and cost-benefit analyses are mandatory in reimbursement applications for new drugs. These analyses are expected to be of high quality, transparency and appropriate to local health system conditions [10-15]. In these analyses, which are usually conducted from the perspective of the health care provider, comparisons are made with the most appropriate current treatment and the results are presented in terms of measures such as Quality-Adjusted Life Years (QALYs) [13,14].

In recent years, analyses based on real-life data have been increasingly used in addition to randomized controlled trials [16]. In some countries, such as the Netherlands and Sweden, pharmacoeconomic data are supportive and therapeutic value may be more decisive in decision-making processes [15]. Many countries have developed methodological guides in order to increase the transparency of evaluation processes. In Turkey, with the increase in regulations in this area, the need for a comprehensive evaluation guide has become even more prominent [9].

To further illustrate the international variability in the implementation of pharmacoeconomic practices, Table 1 presents a comparative overview of how such analyses are applied in selected countries. Specifically, it highlights the degree to which pharmacoeconomic evaluations are mandated, their influence on reimbursement decisions, and the level of methodological transparency in countries such as Australia, Canada, Belgium, Austria, the Netherlands, Sweden, and Türkiye. For instance, Australia and Canada exhibit a high degree of requirement and integration, with pharmacoeconomic evaluations being essential for reimbursement approval. In contrast, Türkiye demonstrates a growing need and evolving capacity for such analyses, although its current level of transparency and standardization remains moderate. This comparison serves to contextualize global disparities in the institutionalization of pharmacoeconomics [10-15]. Complementing this, Figure 1 visually summarizes the dynamic and expanding role of pharmacoeconomic data in national policy-making processes. It underscores how cost-effectiveness and budget impact analyses have become critical instruments for managing healthcare expenditures and evaluating the economic viability of new therapies. The figure also helps to conceptualize the interconnection between data-driven assessments and healthcare sustainability. Together, Table 1 and Figure 1 provide foundational context for understanding how pharmacoeconomic principles are operationalized globally, and they emphasize the need for harmonized strategies to ensure equitable, efficient, and transparent drug policy development [10-15].

Table 1. Status of Application of Pharmacoeconomic Analysis in Some Countries and Its Place in Evaluation Processes [10-15].

Country	Pharmacoeconomic Analysis Requirement	Weight in the Decision Process	Transparency and Standards
Australia, Canada, Belgium, Austria	High	Medium-High	High
Netherlands, Sweden	Middle	Low-Medium	Middle
Türkiye	Increasing Need	Developing	Low-Medium

Figure 1. The role and application of pharmacoeconomic data

This review aims to explore the fundamental principles of health economics and pharmacoeconomics and provide an analytical overview of evaluation methods and their real-world applications. In doing so, it seeks to demonstrate how economic evidence can improve the quality, sustainability, and equity of healthcare delivery. By integrating international examples and data from publicly available online sources, this paper also highlights regional differences, practical challenges, and future perspectives in pharmacoeconomic implementation.

2. Health Economics and Its Relevance to Public Health

Health economics plays a pivotal role in understanding how societies allocate resources to maintain and improve population health. At its core, the discipline examines the production, distribution, and consumption of health and healthcare services under the condition of scarcity. Unlike other branches of economics, health economics must consider not only monetary costs but also broader societal values such as equity, access, and quality of life [17,18].

In public health contexts, health economics provides critical insights into how limited resources can be used to maximize population health outcomes. For instance, economic evaluations help determine which prevention strategies—such as vaccination programs, health screenings, or tobacco control policies-offer the highest value for investment. These evaluations enable policymakers to prioritize interventions that generate the most significant health benefits per unit of expenditure [19,20].

A core principle in health economics is the concept of opportunity cost, which refers to the benefits forgone when

choosing one intervention over another. For example, funding a costly cancer treatment may result in less funding for preventive services, thereby affecting broader public health outcomes. This trade-off analysis is fundamental to rational healthcare planning and highlights the need for evidence-based decision-making [21,22].

Moreover, health economics supports the assessment of health inequalities and access to care. By analyzing cost structures and service utilization patterns, economists can identify disparities in health service delivery and propose mechanisms for improving fairness in healthcare access. This is particularly relevant in systems where out-of-pocket payments limit access for low-income populations [23–25].

In the era of universal health coverage (UHC), promoted by institutions such as the World Health Organization (WHO), health economics provides the analytical framework for designing sustainable and equitable health systems. It guides governments in choosing between competing priorities, such as hospital construction versus primary care investment, or generic versus branded drug procurement [26].

In addition to theoretical significance, practical applications of health economics in public health are well illustrated through real-world examples. For instance, Australia's implementation of a national HPV vaccination program has led to a substantial decrease in cervical cancer incidence and has been widely cited as a cost-effective public health success [27]. Likewise, several EU countries have introduced national screening programs—such as breast and colorectal cancer screenings—based on cost-utility analyses, ensuring the efficient use of public health resources [28].

However, translating economic evaluations into public health practice remains challenging. Key barriers include the lack of high-quality, context-specific data, political variability across jurisdictions, and institutional preferences for short-term budget cycles over long-term investment planning. These limitations often prevent economic evidence from being effectively integrated into decision-making processes. Overcoming such barriers requires multisectoral collaboration, investment in health data systems, and capacity building in economic evaluation methodologies [29-32].

Ultimately, integrating health economic principles into public health policy ensures that decisions are not only clinically sound but also financially responsible and socially just. This integration is essential for achieving long-term health system sustainability and improving health outcomes on a population level.

3. Fundamentals of Pharmacoeconomics

Pharmacoeconomics is a specialized branch of health economics that focuses on evaluating the cost and value of pharmaceutical products and interventions. Its primary aim is to support rational drug use and reimbursement decisions by comparing the economic and clinical outcomes of different therapeutic options. The discipline uses a variety of methods to assess both the direct and indirect costs of pharmaceutical interventions, as well as their health outcomes, such as life years gained, quality of life improvements, or symptom reductions. Pharmacoeconomic evaluations employ various analytical methods depending on the therapeutic context and available data. The most commonly used types of analyses—including cost-minimization, cost-effectiveness, cost-utility, and cost-benefit—are summarized in Table 2.

Table 2. Overview of Pharmacoeconomic Analysis Types, Criteria, and Applications [2, 33-35].

Analysis Type	Evaluated Criteria	Area of Use
Cost-Minimization	Cost	Equivalent treatments
Cost-Effectiveness	Cost + Health outcome	Differently effective treatments
Cost-Usefulness	QALY/DALY	Quality of life focused analysis
Cost-Benefit	Monetary value	Monetary expression of all benefits

The four main types of pharmacoeconomic analyses are:

3.1. Cost-Minimization Analysis (CMA)

Cost-Minimization Analysis (CMA) is the simplest form of pharmacoeconomic evaluation and is applicable only when the clinical outcomes of two or more interventions are proven to be therapeutically equivalent. In this scenario, the focus shifts entirely to identifying the alternative that incurs the least cost, without sacrificing efficacy or safety. This method is commonly applied in contexts such as selecting between branded drugs and their generic counterparts, or between biosimilars and originator biologics, where clinical efficacy and safety are comparable. However, CMA has a major limitation: its validity hinges on robust clinical evidence demonstrating equivalent outcomes. Without such evidence, it becomes inappropriate to use CMA, and more complex analyses like cost-effectiveness or cost-utility analysis should be considered instead. CMA is particularly valuable in resource-constrained settings where cost containment is a primary concern and where therapeutic equivalence has been established through rigorous studies [2, 33-35].

3.2. Cost-Effectiveness Analysis (CEA)

Cost-Effectiveness Analysis (CEA) is one of the most widely used tools in pharmacoeconomics. It compares the costs and health outcomes of two or more alternative interventions, where outcomes are measured in natural units—such as life-years gained, number of cases prevented, hospitalizations avoided, or reduction in blood pressure. CEA is especially appropriate when the interventions produce different levels of effectiveness but aim to treat the same condition. The key output of a CEA is the Incremental Cost-Effectiveness Ratio (ICER), which quantifies the additional cost required to gain one extra unit of outcome. For example, an ICER of $20,000 per life-year gained implies that the new treatment costs $20,000 more than the comparator for each additional life-year it provides. Decision-makers often use ICER thresholds to determine whether an intervention offers sufficient value to be adopted. While CEA is a powerful tool, it may not fully capture differences in patient preferences or quality of life. Therefore, when quality of life becomes a significant factor, cost-utility analysis is usually more appropriate [2, 33-35].

3.3. Cost-Utility Analysis (CUA)

Cost-Utility Analysis (CUA) refines the CEA model by incorporating the impact of interventions on patients' quality of life. It uses standardized units such as QALYs or Disability-Adjusted Life Years (DALYs) that combine both the length and the quality of life.

While both are composite measures, they are not interchangeable. QALYs are commonly used in high-income countries for healthcare decision-making and reimbursement purposes, particularly by agencies such as NICE in the UK or PBAC in Australia. DALYs, on the other hand, are typically applied in global health evaluations and burden of disease studies conducted by institutions such as the World Health Organization and the World Bank [36,37].

This allows decision-makers to compare across diverse health interventions—even between treatments for unrelated conditions—based on their ability to improve overall patient well-being. CUA is especially useful in chronic disease management, cancer care, and palliative treatment evaluations, where interventions might not significantly extend survival but could improve life quality. For example, a cancer drug that prolongs survival by six months with minimal side effects may offer a higher utility score than one that extends life by a year with severe toxicity. CUA facilitates cross-sectoral comparison and is highly relevant for health systems with value-based pricing or outcome-based reimbursement models. Despite its strengths, some critics argue that QALYs may undervalue certain patient populations (e.g., elderly or disabled), raising ethical concerns [2, 33-35].

3.4. Cost-Benefit Analysis (CBA)

Cost-Benefit Analysis (CBA) differs from other economic evaluations by assigning monetary values to both costs and benefits, allowing a direct comparison to determine whether a healthcare intervention yields a net economic gain. If benefits exceed costs, the intervention is considered economically justified. This format is particularly suitable for macroeconomic decision-making, such as evaluating the broader societal value of vaccination programs, smoking cessation policies, or environmental health regulations. One of the main advantages of CBA is its flexibility across sectors. It enables policy-makers to compare healthcare interventions against investments in transportation, education, or housing. However, the most critical challenge lies in accurately quantifying intangible health benefits—such as improved mental health or reduced pain—in monetary terms. Various approaches exist to assign value to health benefits, including the human capital method (valuing productivity gains) or the willingness-to-pay method (valuing what individuals would pay to gain a health benefit or avoid a risk). Nonetheless, due to its complexity and potential subjectivity, CBA is often complemented by other pharmacoeconomic methods [2, 33-35].

In addition, CBA has been criticized for ethical concerns related to the monetization of human life and well-being, which can differ significantly depending on income level, cultural context, and personal values. Other types of economic analyses also have notable limitations. For instance, Cost-Minimization Analysis (CMA) is only valid when two or more interventions have been proven to be clinically equivalent—an assumption that is often difficult to establish in real-world settings [38,39]. Cost-Utility Analysis (CUA), while allowing for quality-adjusted comparisons using metrics like QALY or DALY, has been challenged for oversimplifying patient experiences and potentially underrepresenting certain populations, such as the elderly or those with chronic disabilities [40].

Moreover, the outcome of any pharmacoeconomic analysis is highly dependent on the perspective adopted during the evaluation. Analyses may be conducted from the perspective of the healthcare payer (e.g., insurance systems), the individual patient, or society as a whole. Each perspective incorporates different sets of costs and outcomes: for example, the societal perspective often includes indirect costs such as productivity loss and caregiver burden, while the payer perspective typically focuses solely on direct medical costs. Therefore, clearly defining the analytical perspective is essential for interpreting results accurately and ensuring policy relevance [41-43].

4. Applications of Pharmacoeconomic Studies in Drug Reimbursement and Policy

Pharmacoeconomic studies have become an essential component of modern drug policy, especially in the context of limited healthcare budgets and rising pharmaceutical expenditures. These studies assist decision-makers in determining whether a drug provides sufficient value to justify its cost and whether it should be included in public or private reimbursement lists.

Many countries have institutionalized the use of pharmacoeconomic evidence in their health technology assessment (HTA) processes. For instance, the National Institute for Health and Care Excellence (NICE) in the United Kingdom formally evaluates the cost-effectiveness of new drugs before they are funded by the National Health Service (NHS). Similarly, countries like Canada (CADTH), Australia (PBAC), and Germany (IQWiG) have well-established mechanisms for integrating economic evaluations into policy decisions [44,45]. A global overview of pharmacoeconomic integration levels into national health systems is illustrated in Figure 2 and Table 3 [2, 33-35].

Table 3. Overview of HTA and Pharmacoeconomic Implementation by Country [2, 33-35].

Country/Region	HTA and Pharmacoeconomics Implementation	References
United Kingdom (NICE)	Cost-effectiveness assessment mandatory before NHS reimbursement of medicines	[44,46]
Germany (IQWiG)	Clinical and economic evidence are assessed together	[46,47]
Canada (CADTH))	National guidelines set economic evaluation standards	[45,48]
Australia (PBAC)	Pharmacoeconomic analysis mandatory in reimbursement decisions	[46,48]
Egypt	National pharmacoeconomic guidelines developed and integrated into HTA processes	[45]
Asian Countries	Pharmacoeconomic evidence introduced in HTA in South Korea, Thailand and Taiwan	[49]

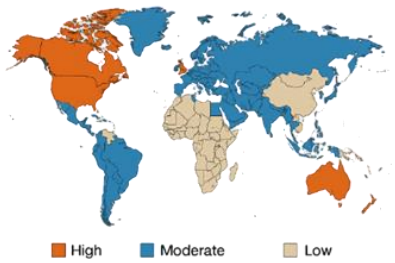

Figure 2. Global Integration of Pharmacoeconomic Evaluations into Reimbursement and HTA Systems

In these systems, cost-effectiveness thresholds are often used to guide decisions. For example, NICE uses a commonly cited threshold of £20,000–£30,000 per QALY gained. A drug that exceeds this threshold may be denied reimbursement unless it targets rare diseases or meets additional value criteria [44,46].

Pharmacoeconomic evaluations are also used in price negotiations between pharmaceutical companies and governments. In countries with reference pricing or external price benchmarking, economic evidence is critical for justifying price levels. Budget impact analyses help forecast the short-term financial consequences of adopting a new therapy and are frequently required as part of a reimbursement dossier submission [50-52].

In Turkey, the Social Security Institution (SGK) plays a central role in determining which drugs are reimbursed. Since 2009, SGK has increasingly required pharmacoeconomic evaluations for expensive or innovative drugs seeking inclusion in the reimbursement list. The Turkish Medicines and Medical Devices Agency (TMMDA) and national guidelines for pharmacoeconomic submissions further support this process, although the use of pharmacoeconomics is still developing compared to some OECD countries [9,53].

Despite growing global adoption, challenges remain. These include inconsistent data quality, lack of transparency in decision-making, and limited local expertise in economic modeling—particularly in low- and middle-income countries. Moreover, the dynamic nature of drug markets means that cost-effectiveness evaluations must be updated regularly to reflect changing prices, new clinical data, and population needs. In summary, pharmacoeconomic studies provide vital support for evidence-based drug reimbursement decisions, contribute to rational drug pricing, and help ensure that healthcare systems invest in interventions that offer real value to patients and society.

In the European context, pharmacoeconomic evaluations are increasingly influenced by collaborative initiatives and evolving policy frameworks. The European Network for Health Technology Assessment (EUnetHTA) has played a central role in supporting cross-national cooperation in HTA by developing methodological guidelines and fostering information sharing across EU member states [54]. Moreover, starting in 2025, the EU Regulation on Health Technology Assessment will make joint clinical assessments mandatory for certain categories of health technologies, significantly shaping future pharmacoeconomic and reimbursement practices within the European Union [55,56].

5. Global Case Studies and Data from Online Sources

Pharmacoeconomic implementation varies widely across countries, influenced by differences in healthcare financing models, policy priorities, and institutional capacity. Several nations have established formal mechanisms to integrate economic evaluations into health policy, while others are still developing or adopting these frameworks [57]. This section presents selected case studies supported by data from global institutions such as the World Health Organization (WHO), OECD, and national health agencies.

5.1. United Kingdom – A Pioneer in Formal HTA

The United Kingdom's National Institute for Health and Care Excellence (NICE) is internationally recognized for its structured and transparent approach to health technology assessment (HTA). Since its establishment in 1999, NICE has used cost-effectiveness thresholds (typically £20,000–£30,000 per QALY) to determine which drugs the National Health Service (NHS) should fund. NICE also publishes public guidance on cost-effectiveness analyses, promoting transparency and consistency in policy decisions [58-60].

5.2. Canada – Evidence-Based Drug Reimbursement

Canada uses the Canadian Agency for Drugs and Technologies in Health (CADTH) to assess new pharmaceuticals. CADTH recommendations are critical in decisions made by the national and provincial drug plans. Their economic analyses emphasize cost-utility, frequently using QALY-based models. Public datasets and health system cost structures in Canada are openly accessible, allowing replication and validation of pharmacoeconomic studies [61,62].

5.3. Turkey – Emerging Integration of Pharmacoeconomics

In Turkey, the Social Security Institution (SGK) oversees pharmaceutical reimbursement decisions. Although pharmacoeconomics has been officially incorporated since 2009, its application is still evolving. The Turkish Medicines and Medical Devices Agency (TMMDA) and national pharmacoeconomic guidelines have been developed, but there is limited local capacity for advanced modeling. WHO country reports indicate an increasing interest in HTA development, with Turkey participating in regional capacity-building initiatives [9,53,63].

5.4. Germany – Emphasis on Added Therapeutic Value

Germany employs a distinct model where the Institute for Quality and Efficiency in Health Care (IQWiG) assesses the added therapeutic value of new drugs. While economic evaluation plays a secondary role, price negotiations with statutory health insurance providers are strongly influenced by these assessments. Budget impact and comparative effectiveness are considered more than strict ICER thresholds [64,65].

5.5. WHO and OECD – Global Data on Health Spending and Value

The OECD Health Statistics and WHO Global Health Expenditure Database provide robust data for comparative analysis. According to 2023 OECD reports, countries that systematically use pharmacoeconomics—such as the UK, Sweden, and Australia—achieve better cost-containment without compromising access to essential medicines. WHO's 2022 report on health technology assessment in low- and middle-income countries emphasizes the need for regional collaboration and standardization in economic evaluation [66,67]. A comparative overview of global health expenditure patterns and projections for 2050 across different country groups is presented in Table 4.

Table 4. Distribution and Trends of Global Health Expenditures by Country Groups [66,67].

Country Group	2013 Per Capita Expenditure ($)	Global Spending Share (2013)	2050 Projection
G7	4.747	%53,2	Share is decreasing
BRICS	1.004	%20,2	Share is increasing
Low Income	40 (2016)	%0,4 (2016)	%0,6 (2050)
High Income	5.252 (2016)	-	-

The projected changes in global health expenditure shares reflect broader economic and demographic transformations across country groups. The declining share of the G7 nations can be attributed to demographic aging, slower GDP growth, and already high baseline health spending levels. In contrast, the BRICS countries are expected to account for an increasing share due to accelerated economic development, rising middle-class populations, and expanded investments in healthcare infrastructure. These shifting patterns underscore the growing importance of emerging economies in shaping future global health financing priorities [66,67].

6. Challenges and Limitations in Pharmacoeconomic Evaluations

Despite the increasing adoption of pharmacoeconomic methods worldwide, several challenges continue to hinder their consistent and effective application in healthcare decision-making. These limitations arise from methodological complexities, data availability, ethical concerns, and system-level constraints [68,69].

6.1. Methodological Challenges

Pharmacoeconomic evaluations often rely on model-based simulations, such as decision trees and Markov models. These methods require numerous assumptions regarding disease progression, treatment efficacy, adherence rates, and cost estimates. If these assumptions are inaccurate or not transparent, the model outcomes can be misleading. Additionally, selecting appropriate outcome measures—such as QALYs or DALYs—can be contentious and may not reflect all dimensions of patient benefit, especially in conditions affecting quality of life rather than survival [68,70].

6.2. Data Availability and Quality

High-quality, local, real-world data is essential for robust pharmacoeconomic analysis. However, in many countries—especially low- and middle-income settings—comprehensive health data systems are underdeveloped. This results in reliance on extrapolated or foreign data, which may not accurately reflect the local population or healthcare context. Moreover, inconsistent cost databases, lack of transparency in drug pricing, and limited access to utilization data further compromise analysis validity [71,72].

6.3. Ethical and Equity Considerations

Economic evaluations inherently involve value judgments about which outcomes matter most and who should benefit from limited resources. This raises ethical concerns, particularly when cost-effectiveness thresholds are used to deny access to treatments for patients with rare diseases or lower life expectancy. There is ongoing debate about whether QALY-based evaluations undervalue treatments for the elderly, disabled, or chronically ill [73,74].

6.4. Systemic Barriers

Even when high-quality evaluations exist, institutional resistance, lack of political will, or limited technical expertise can prevent their integration into policy. In countries with fragmented healthcare systems or weak governance structures, pharmacoeconomic evidence may be ignored or selectively applied. Furthermore, pharmaceutical industry influence and lobbying may undermine objective assessment processes [75,76].

6.5. Updating and Sustainability of Models

Healthcare technologies evolve rapidly, and prices change over time due to competition, patent expiration, or policy interventions. Therefore, pharmacoeconomic evaluations need regular updates to remain relevant. However, updating models requires technical skills, resources, and institutional commitment—many of which are lacking in practice [77,78].

A notable example highlighting the risks of outdated or inaccurate modeling is the case of the Alzheimer's drug aducanumab in the United States. The initial cost-effectiveness analysis was based on optimistic assumptions about the drug's long-term clinical benefits, despite limited clinical trial data. This led to its conditional approval and anticipated reimbursement by Medicare. However, significant backlash from the scientific community and healthcare economists eventually prompted Medicare to limit coverage only to patients enrolled in clinical trials. This case underscores how uncertain model assumptions and insufficient evidence can impact both reimbursement policies and public trust in pharmacoeconomic evaluations [79-81].

In conclusion, while pharmacoeconomics provides valuable tools for improving healthcare efficiency and accountability, overcoming these limitations is essential for its broader and more equitable implementation. Investment in data infrastructure, capacity building, transparent decision-making processes, and ethical guidelines will be critical to realizing the full potential of pharmacoeconomic analysis.

7. Conclusions and Future Perspectives

Pharmacoeconomics has become a cornerstone of modern healthcare systems by offering a structured and evidence-based approach to assessing the value of pharmaceutical interventions. According to numerous studies and global policy reports, economic evaluations—particularly cost-effectiveness, cost-utility, and budget impact analyses—serve as critical tools for aligning healthcare spending with clinical benefits, ensuring that limited financial resources are utilized efficiently, equitably, and transparently. High-income countries have already institutionalized these evaluations within their reimbursement systems and health technology assessment (HTA) frameworks, leading to more consistent and sustainable policy decisions.

This review has synthesized key findings from the literature, including the theoretical foundations of health economics, the practical implementation of pharmacoeconomic methodologies, and cross-country comparisons that demonstrate varying levels of adoption. While countries such as the United Kingdom, Canada, and Australia have well-established systems, many low- and middle-income countries still face barriers such as inadequate data infrastructure, insufficient technical expertise, and fragmented institutional support. These findings are primarily derived from the cited literature and publicly available international data sources.

Building on this synthesis, and reflecting the author's perspective, several forward-looking trends are expected to shape the future of pharmacoeconomics. First, the rise of digital health technologies and the increasing availability of real-world evidence will enhance the granularity and relevance of economic data, allowing for more personalized and timely evaluations. Second, the integration of machine learning and artificial intelligence into economic modeling holds great promise for improving predictive accuracy and responsiveness to changing clinical and economic conditions. Third, the evolution of ethical frameworks will be essential to address concerns around equity, societal values, and the limitations of cost-effectiveness thresholds—particularly for marginalized populations. Finally, global collaboration focused on data sharing, methodological harmonization, and capacity building will be vital for narrowing disparities between health systems and enabling broader application of pharmacoeconomic principles.

Moreover, as value-based healthcare models continue to expand, the role of pharmacoeconomic evaluations will no longer be limited to reimbursement decisions alone. Value-based healthcare refers to a healthcare delivery approach that emphasizes achieving the best possible health outcomes relative to the resources used. It shifts the focus from the volume of services provided to the value generated for patients, promoting efficient, patient-centered, and outcome-oriented care. In this context, pharmacoeconomic analyses help define and quantify value by integrating clinical effectiveness, cost, and impact on quality of life. They are increasingly being used to guide performance-based pricing agreements, formulary selections, and even clinical guideline development—ensuring that therapeutic choices are not only clinically effective but also economically justified.

In conclusion, based on both the literature reviewed and the author's analytical interpretation, pharmacoeconomics represents an indispensable tool for achieving sustainable, transparent, and patient-centered healthcare systems. A collaborative effort among policymakers, clinicians, economists, and researchers will be necessary to integrate economic evidence into real-world decision-making processes and to ensure that every healthcare investment yields measurable and equitable health outcomes across populations.

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