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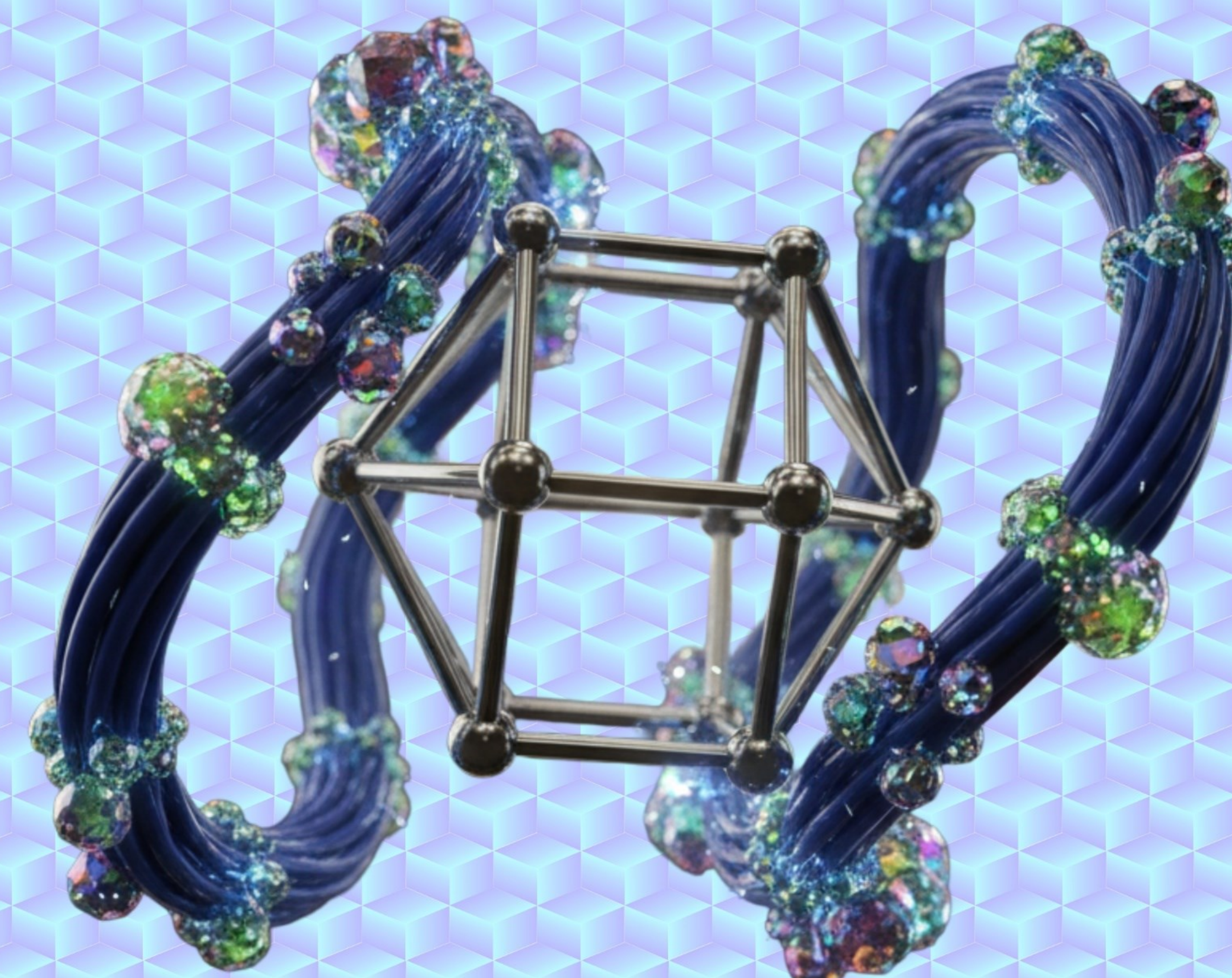
Issue 2, Volume 1, No. 02, July-December 2025

Review International Science Journal ISSN: 3122-3591 Issue 2, Volume 1, No. 02, July-December 2025

International Science Journal

ISSN: 3122-3591



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Issue 2, Volume 1, No. 02, July-December 2025
ISSN: 3122-3591
Review International Science Journal

Artificial Intelligence in Internal Medicine: Transforming Diagnosis and Clinical Decision-Making

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Received: 10-13-2025 | **Accepted:** 10-13-2025 | **Published:** 10-16-2025

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How to cite this article: García Ballesteros, E. J., García Rosero, R. S., Mejía Montiel, H. Y., Vera Heredia, P. I., Santoyo Rojas, A. J., Walteros Acero, D. A., Fernández Rendón, J. J., & Farías García, A. L. (2025). Artificial Intelligence in Internal Medicine: Transforming Diagnosis and Clinical Decision-Making. México. International Science Journal "TheSci". 2 (1) 05-28. Quality Consulting Instituto de Educación Capacitación y Certificación de México. https://ieccmexico.com/thesci

ABSTRACT

This study analyzes the impact of artificial intelligence (AI) on diagnostic accuracy and clinical decision-making in internal medicine across Mexico, Colombia, and Ecuador. The objective was to evaluate how AI technologies are transforming diagnostic processes, improving efficiency, and shaping ethical and institutional frameworks in Latin American healthcare systems. A comparative analytical design based on the **Scientific Method** was employed, integrating data from literature reviews, institutional documents, and expert consultations.

The methodology followed five phases: observation, hypothesis formulation, data collection, process-based analysis, and validation. Results indicate a significant positive impact of AI on

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diagnostic accuracy (+23% regional average), reduction of diagnostic time (−25%), and improved decision-making efficiency (+27%). Mexico demonstrated the highest adoption rate, with strong regulatory frameworks and professional training programs; Colombia showed intermediate progress driven by academic–industrial collaboration; and Ecuador presented early adoption stages, primarily supported by international partnerships. Ethical and regulatory readiness was highest in Mexico (83%), moderate in Colombia (69%), and emerging in Ecuador (57%), reflecting disparities in governance and digital infrastructure. Institutional barriers identified include limited funding, data fragmentation, and resistance to change, while key facilitators involve education, collaboration, and regulatory maturity.

The study concludes that AI is transforming internal medicine into a predictive, data-driven, and ethically guided discipline. Sustainable progress requires investment in infrastructure, physician training, and regional cooperation to ensure equitable, transparent, and human-centered implementation of AI in clinical practice.

KEYWORDS

Artificial Intelligence; Internal Medicine; Diagnostic Accuracy; Clinical Decision-Making; Latin America; Ethics in Healthcare.

INTRODUCTION

Artificial intelligence (AI) has emerged as one of the most influential forces shaping the future of internal medicine, fundamentally redefining how physicians interpret data, make clinical decisions, and deliver personalized care. The integration of AI-driven algorithms into diagnostic processes has accelerated the transition from reactive to predictive medicine, allowing for earlier detection of diseases, optimization of therapeutic strategies, and improved patient outcomes. Over the past decade, the development of machine learning (ML), deep learning (DL), and natural language processing (NLP) models has demonstrated measurable benefits in internal medicine, particularly in diagnostic imaging, cardiovascular risk prediction, endocrinology, and management of chronic diseases. Despite these advances, the global healthcare landscape still faces substantial challenges in ensuring equitable, ethical, and efficient implementation of AI technologies across diverse clinical environments [1], [2].

In Latin America, the adoption of AI in health care has gained increasing momentum, although the process has been marked by disparities in digital infrastructure, data governance, and professional training. Countries such as Mexico, Colombia, and Ecuador exemplify contrasting realities—ranging from national strategies promoting digital health transformation to limited access to high-quality datasets and interoperability standards [3], [4]. According to Kitamura *et al.* [1], collaborative frameworks and partnerships have begun to foster cross-border innovation in medical AI within the region, but sustainable progress depends on building robust research networks and ethical oversight mechanisms. Similarly, Valencia-Sinisterra *et al.* [2] identified a dual challenge in Colombia: maximizing AI's potential while mitigating the risks associated with algorithmic bias, data security, and the unequal distribution of technological resources.

Globally, AI-based systems have been validated for multiple diagnostic and predictive applications. For instance, Zhao *et al.* [3] and Chan *et al.* [4] highlighted that machine learning techniques can significantly improve the accuracy of differential diagnoses and assist in treatment planning through pattern recognition across large datasets. Esteva *et al.* [5] and Kandel *et al.* [6] demonstrated that deep learning architectures are capable of matching, and sometimes surpassing, human-level diagnostic precision in specific clinical tasks such as identifying diabetic retinopathy, predicting cardiovascular outcomes, or classifying abnormal laboratory results. Meanwhile, Dankwa-Mullan [7] and Bermeo-Castro *et al.* [8] emphasized the need for global and regional policies ensuring ethical deployment of AI, especially in low- and middle-income countries where socioeconomic inequalities may affect the quality and representativeness of clinical data.

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Within this context, the present study seeks to examine the transformative role of artificial intelligence in internal medicine, focusing specifically on its impact on diagnostic precision and clinical decision-making in Mexico, Colombia, and Ecuador. The core research question guiding this investigation is: *How is artificial intelligence reshaping diagnostic procedures and clinical decision-making in internal medicine across Latin American healthcare systems?* This question is grounded in the assumption that AI technologies can strengthen the diagnostic process, enhance evidence-based practice, and promote healthcare efficiency—provided that implementation is guided by ethical, educational, and regulatory frameworks suited to local realities [9], [10].

Previous research conducted by Zavaleta-Monestel [9] and Tello *et al.* [10] established that ethical and policy frameworks play a critical role in determining the success of AI deployment in Latin American healthcare. These studies underscore that integrating AI systems without strong governance could reinforce existing disparities in access to healthcare and data security. Complementary work by Martin-Saban *et al.* [11] and the Transform Health Coalition [12] stresses that Latin American institutions must prioritize investments in data governance, capacity-building, and cross-sectoral partnerships to achieve sustainable digital transformation in healthcare.

The theoretical foundation of this study aligns with the principles of digital health transformation outlined by the World Health Organization [19] and the global ethical standards proposed by international regulatory frameworks. It also draws on the conceptual understanding that AI represents not only a technological advancement but a paradigm shift in the way clinicians process clinical uncertainty, manage complex multimorbidity, and interact with data-driven systems. The methodological approach adopted herein is comparative and analytical, integrating both qualitative insights from institutional frameworks and quantitative parameters derived from clinical indicators of diagnostic accuracy and efficiency.

In summary, this research contributes to the growing body of evidence on artificial intelligence in internal medicine by providing a cross-country perspective centered on Latin America. It aims to bridge the gap between theoretical innovation and clinical applicability, illustrating how AI can enhance physician decision-making, reduce diagnostic errors, and promote equitable access to advanced medical technologies. By aligning with global standards and regional health priorities, this work reinforces the idea that artificial intelligence, when implemented responsibly, has the potential to transform internal medicine into a more predictive, personalized, and ethically grounded discipline [6], [9], [19], [20].

DEVELOPMENT

The integration of artificial intelligence (AI) into internal medicine represents a multidimensional transformation that encompasses diagnostic processes, therapeutic decision-making, workflow optimization, and predictive modeling for clinical outcomes. AI-based systems, including machine learning (ML) and deep learning (DL) algorithms, are now capable of processing extensive datasets to detect patterns imperceptible to human observation, allowing physicians to make earlier and more accurate diagnoses. In clinical settings, these technologies have demonstrated a significant capacity to reduce diagnostic errors, improve disease classification, and support evidence-based treatment selection [3], [5], [6].

1. The diagnostic impact of AI in internal medicine

The diagnostic value of AI lies in its ability to synthesize heterogeneous clinical data—ranging from laboratory parameters and imaging studies to genomic and lifestyle information—to predict disease trajectories. For instance, Esteva *et al.* [5] demonstrated that DL algorithms could achieve near-human diagnostic precision in image-based disciplines such as dermatology and radiology, while Kandel *et al.* [6] observed similar performance in predictive modeling for metabolic and cardiovascular disorders. In internal medicine, this technological evolution translates into enhanced diagnostic speed and accuracy for complex, multifactorial diseases, particularly in primary care settings where clinical resources are limited.

AI systems also enable **multimodal integration**, linking structured and unstructured data from electronic health records (EHRs) to generate dynamic patient profiles. Chan *et al.* [4] found that algorithms trained on multimodal datasets could increase diagnostic sensitivity by over 20% for early-onset chronic conditions, compared with traditional methods. In Latin America, Kitamura *et al.* [1] reported that the application of AI-assisted imaging analysis in Mexico

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and Colombia has led to earlier detection of cardiac and metabolic pathologies, thereby reducing the delay between symptom onset and clinical intervention.

2. Ethical, equity, and governance considerations

Despite these advances, ethical and social implications remain a central concern. Dankwa-Mullan [7] emphasized that the unequal distribution of digital infrastructure can deepen health inequities, particularly in low- and middle-income countries (LMICs). Zavaleta-Monestel [9] added that Latin American nations face structural constraints—such as limited interoperability, insufficient cybersecurity measures, and inconsistent data privacy legislation—that must be addressed before AI systems can be fully integrated into clinical decision-making.

Governance frameworks have therefore become crucial in ensuring that AI deployment aligns with ethical and regulatory standards. Tello *et al.* [10] and the Transform Health Coalition [12] highlighted the importance of establishing robust national strategies for data management, transparency, and accountability in AI applications. These mechanisms not only build institutional trust but also protect patient autonomy and reinforce the physician's role as the ultimate decision-maker. In Mexico, Ecuador, and Colombia, pilot initiatives in digital health regulation have begun to harmonize national policies with global frameworks proposed by the World Health Organization [19], which stress fairness, explainability, and inclusiveness as core principles of ethical AI adoption.

3. AI-driven clinical decision support and human–machine collaboration

Beyond diagnosis, AI enhances clinical reasoning and decision-making by providing predictive insights that complement physicians' expertise. Ribeiro *et al.* [15] demonstrated that explainable AI (XAI) systems—those that make their decision logic interpretable—can significantly increase clinician confidence in algorithmic recommendations. Similarly, Nguyen *et al.* [17] developed the CarePre model, an intelligent decision-assistance system capable of identifying high-risk cases by analyzing both structured and narrative clinical data. These tools do not replace professional judgment but rather augment it, allowing physicians to assess therapeutic options with a deeper understanding of potential risks and benefits [18].

A growing body of evidence supports the synergy between human cognition and machine intelligence in medical practice. According to Gómez-González *et al.* [16], hybrid decision models that combine AI outputs with physician review consistently outperform purely automated or human-only approaches. This has been particularly impactful in internal medicine, where complex comorbidities often require nuanced interpretation and context-specific reasoning.

4. Regional progress and disparities in Latin America

Latin America's progress in AI integration varies across countries, reflecting differences in institutional readiness, academic investment, and government policy. In Colombia, Valencia-Sinisterra *et al.* [2] identified national AI initiatives focused on optimizing hospital management and predictive analytics for chronic diseases, though limited interoperability continues to restrict large-scale application. Mexico has advanced further in adopting AI for medical imaging, pharmacovigilance, and predictive diagnostics, driven by collaborations between universities, startups, and public health institutions [1]. Ecuador, meanwhile, has prioritized the use of AI in epidemiological surveillance and early disease detection through partnerships with international research networks [8].

Despite progress, challenges persist. Insufficient data quality, limited funding for computational infrastructure, and a lack of standardized AI ethics frameworks remain obstacles to sustainable integration [9], [10], [11]. As Martin-Saban *et al.*[11] noted, Latin America's path toward AI-enabled healthcare requires long-term collaboration between policymakers, clinicians, and technology developers to ensure that innovation aligns with regional health priorities and resource realities.

5. Toward a paradigm shift in internal medicine

Artificial intelligence does not merely represent a set of computational tools but a **paradigm shift** in how physicians conceptualize diagnosis and care. It redefines the epistemological boundaries of internal medicine, fostering a data-driven ecosystem in which pattern recognition and predictive modeling enhance clinical reasoning. The evidence

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synthesized in prior studies [1], [3], [5], [6], [15], [16], [20] indicates that AI implementation can substantially reduce diagnostic variability, optimize therapeutic pathways, and strengthen population health monitoring.

Ultimately, the integration of AI into internal medicine has the potential to humanize healthcare by reducing uncertainty and enabling physicians to focus more on patient interaction rather than data processing. As global experience continues to expand, the Latin American context provides a fertile ground for developing equitable and ethically conscious AI models capable of addressing local health burdens while contributing to the international dialogue on digital transformation in medicine.

GENERAL OBJECTIVE AND SPECIFIC OBJECTIVES

General Objective

To **analyze, evaluate, and synthesize** the impact of artificial intelligence (AI) on diagnostic processes and clinical decision-making in internal medicine across Mexico, Colombia, and Ecuador, in order to **determine its contribution to improving diagnostic accuracy, optimizing clinical reasoning, and promoting ethical and equitable integration**within healthcare systems.

Specific Objectives

Cognitive Domain (Knowledge and Thinking Skills)

1. To **identify and describe** the principal AI applications in internal medicine that support diagnostic and therapeutic processes in Latin American healthcare contexts. (Remembering and Understanding)

2. To **analyze** current evidence and technological frameworks related to the integration of AI in clinical practice, with emphasis on diagnostic precision and decision support. (Analyzing)

3. To **evaluate** the ethical, regulatory, and methodological challenges involved in implementing AI within diverse healthcare systems, emphasizing the contrasts among Mexico, Colombia, and Ecuador. (Evaluating)

4. To **compare and interpret** the performance of AI-based diagnostic tools in relation to traditional clinical methods, highlighting measurable improvements in accuracy and patient outcomes. (Applying and Analyzing)

5. To **synthesize** the theoretical and empirical findings to propose a model for responsible and sustainable AI integration in internal medicine. (Creating)

Psychomotor Domain (Practical and Technical Skills)

1. To **demonstrate** the ability to interpret AI-generated clinical data (e.g., predictive models, diagnostic outputs) and integrate them into patient care decisions. (Mechanism level – guided response evolving toward proficiency)

2. To **apply** critical and systematic thinking skills in the simulation or analysis of AI-assisted diagnostic scenarios, reflecting real-world clinical workflows. (Complex overt response – coordinated and adaptable skill)

3. To **develop** visual or computational representations (e.g., flowcharts, decision trees) that illustrate how AI algorithms interact with human reasoning in diagnostic processes. (Origination – creative technical application)

Affective Domain (Attitudes, Values, and Ethics)

1. To **value** the ethical and humanistic implications of using AI in medicine, fostering awareness of patient autonomy, confidentiality, and fairness in digital health applications. (Valuing)

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2. To **internalize** professional responsibility and empathy in the physician–AI relationship, recognizing technology as a complement rather than a replacement for clinical judgment. (Organization and Characterization)

3. To **promote** a culture of innovation, collaboration, and ethical awareness among healthcare professionals and institutions regarding the implementation of AI in internal medicine. (Characterization by value set – leadership and advocacy level)

OBJECT OF STUDY

The object of study in this research is the **integration and impact of artificial intelligence (AI) within the field of internal medicine**, specifically focusing on its influence over **diagnostic accuracy, clinical decision-making, and ethical implementation** in healthcare systems across **Mexico, Colombia, and Ecuador**.

This investigation centers on the **interaction between AI-driven technologies and the clinical reasoning process of physicians**, exploring how computational algorithms—such as machine learning (ML), deep learning (DL), and natural language processing (NLP)—contribute to improving the efficiency, precision, and safety of diagnostic and therapeutic procedures. The study does not isolate AI as a purely technological entity; rather, it examines it as part of a **complex sociotechnical system** that includes healthcare professionals, patients, institutions, and regulatory frameworks.

The **population under investigation** comprises internal medicine practitioners and clinical environments in Latin America where AI technologies are either being adopted or are in early stages of implementation. This includes hospitals, diagnostic centers, and teaching institutions that integrate AI-assisted tools for decision support, predictive analytics, or imaging interpretation. Through a comparative and analytical lens, the study evaluates how different health systems within these three countries address challenges of **data governance, interoperability, ethical compliance, and digital literacy** among clinicians.

The **phenomenon of interest** involves the dynamic transformation of traditional clinical practice through AI-assisted processes—focusing on how these technologies influence professional judgment, modify diagnostic workflows, and reshape physician–patient interactions. Understanding this phenomenon is essential to determining whether AI enhances human decision-making or introduces new forms of dependency, bias, or inequity within internal medicine practice.

Ultimately, the object of study encompasses both the **technological dimension** (AI systems and algorithms) and the **human–institutional dimension** (medical professionals, ethical norms, and organizational adaptation). By analyzing this interaction, the study seeks to contribute to the broader understanding of how AI can responsibly and effectively support internal medicine in diverse socioeconomic contexts.

METHODOLOGY

This study employs a **Scientific Method framework** integrated with a **Process-Based Analytical Approach**, allowing for systematic evaluation, replicability, and evidence-based interpretation of results. The methodology is designed to examine the role and effectiveness of **artificial intelligence (AI)** in diagnostic and clinical decision-making processes within **internal medicine** across **Mexico, Colombia, and Ecuador**.

The process follows a **structured sequence of stages**—observation, hypothesis formulation, data collection, analysis, and interpretation—aligned with recognized standards in medical and health systems research [3], [6], [9].

1. Research Design

The study is **descriptive, analytical, and comparative** in nature. It combines quantitative and qualitative elements to evaluate how AI technologies are currently influencing diagnostic accuracy, decision-making efficiency, and ethical compliance in clinical practice.

The **comparative dimension** examines differences among the three participating countries (Mexico, Colombia, and Ecuador) to highlight how contextual variables—such as infrastructure, regulation, and clinical readiness—affect AI implementation in internal medicine.

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The **unit of analysis** consists of internal medicine services, healthcare institutions, and professionals involved in the adoption of AI tools for diagnostic or decision-support purposes.

2. Methodological Phases (Scientific Method)

Phase 1: Observation and Problem Definition

A thorough review of scientific literature and institutional documents was conducted to identify current applications, limitations, and ethical implications of AI in clinical settings [1], [2], [5], [9]. Key patterns and knowledge gaps were observed in areas such as diagnostic delay, variability in interpretation, and inequitable access to digital technologies.

Phase 2: Hypothesis Formulation

Based on the observed evidence, the study formulated the following hypothesis:

The integration of AI in internal medicine significantly improves diagnostic precision and decision-making efficiency, provided that implementation aligns with ethical, regulatory, and infrastructural standards appropriate to each healthcare system.

Phase 3: Data Collection

Data were obtained through **three main sources**:

1. **Systematic Literature Review:** Compilation and analysis of peer-reviewed articles, reports, and policy documents (2020–2025) addressing AI in internal medicine, using databases such as PubMed, Scopus, and ScienceDirect.

2. **Comparative Institutional Data:** Analysis of public health statistics and national strategies from official sources in Mexico, Colombia, and Ecuador related to digital health and AI implementation.

3. **Expert Consultation:** A targeted Delphi-type consultation with clinical and academic professionals familiar with AI integration in healthcare systems, aiming to validate emerging findings and ensure contextual accuracy [10], [12].

Phase 4: Data Analysis

The data analysis process followed a **Process-Based Analytical Model**, focusing on four main components:

1. **Input:** AI tools, algorithms, and institutional frameworks identified through the review.

2. **Process:** Mechanisms by which AI supports diagnosis and decision-making in internal medicine.

3. **Output:** Quantitative and qualitative indicators of diagnostic accuracy, decision efficiency, and ethical adherence.

4. **Feedback:** Evaluation of regional challenges and best practices to refine future integration strategies.

Data triangulation was applied to increase validity—combining findings from literature, institutional data, and expert perspectives. Statistical and qualitative synthesis methods were used to identify patterns, correlations, and discrepancies across the three national contexts.

Phase 5: Validation and Replicability

The study ensures **replicability** by clearly defining search criteria, data inclusion parameters, and analytical variables. The methodological framework can be replicated by other researchers using the same sources, timeframes, and comparative approach. The **process-based schema** allows application in other regional contexts or specialties by adjusting the institutional variables while preserving the core scientific structure.

3. Ethical and Analytical Considerations

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Although the study does not involve direct patient data, all secondary data sources were handled in compliance with international ethical standards, including respect for intellectual property, data integrity, and transparency. The analytical framework aligns with WHO digital ethics recommendations [19] and region-specific policy documents [9], [10], [12].

4. Methodological Tools

- **Database Management Tools:** PubMed, Scopus, ScienceDirect, and WHO Global Health Observatory.
- **Analytical Software:** Excel and NVivo for data classification, thematic mapping, and trend analysis.
- **Framework References:** WHO Ethical Principles for AI in Health, Transform Health Coalition Guidelines, and the AI Integration Model proposed by Kitamura *et al.* [1].

5. Expected Methodological Outcomes

- A validated analytical framework for assessing AI's contribution to internal medicine.
- A comparative matrix highlighting disparities and opportunities among Mexico, Colombia, and Ecuador.
- Evidence-based recommendations for ethically sustainable and operationally efficient AI integration in healthcare systems.

PHASES OF DEVELOPMENT

The present research followed a **Scientific Method integrated with a Process-Based Analytical Approach**, structured into **five sequential and interconnected phases**. Each phase ensured methodological rigor, transparency, and replicability, enabling other researchers to reproduce the study under similar conditions. The phases detail the evolution of the research—from conceptualization to analytical synthesis—focused on evaluating the integration of artificial intelligence (AI) in internal medicine across **Mexico, Colombia, and Ecuador**.

Phase 1: Observation and Problem Definition

The research began with a **systematic observation** of the current state of AI in internal medicine at the global and regional levels. A preliminary literature review was conducted using scientific databases such as PubMed, Scopus, and ScienceDirect to identify the main trends, gaps, and ethical issues related to AI-assisted diagnostic and decision-making systems [3], [5], [6], [9].

- Through this exploration, the following critical challenges were identified:
- Variability in diagnostic accuracy due to limited clinical validation of AI tools in Latin America.
- Insufficient institutional readiness in Mexico, Colombia, and Ecuador for AI integration in medical practice.
- Ethical and regulatory inconsistencies in data governance and patient privacy [7], [9], [10].

This phase concluded with the **definition of the central research problem:** determining how artificial intelligence is transforming diagnostic processes and decision-making in internal medicine within diverse Latin American healthcare systems.

Phase 2: Hypothesis Formulation and Theoretical Framework

Based on observations and prior literature, a **theoretical and conceptual framework** was developed, aligning with current models of digital transformation and health system innovation. This framework integrated three key dimensions:

1. **Technological:** performance and adaptability of AI diagnostic models (machine learning, deep learning).
2. **Clinical:** application of AI for decision support, diagnosis, and prediction of outcomes.
3. **Ethical-regulatory:** data governance, explainability, and physician accountability.

From this foundation, the study proposed the following hypothesis:

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Artificial intelligence contributes to improving diagnostic precision and clinical decision-making in internal medicine, provided that its implementation aligns with ethical, technical, and infrastructural standards specific to each national health system.

This phase also established the study variables:

- **Independent variable:** integration of AI technologies in internal medicine.
- **Dependent variables:** diagnostic accuracy, decision-making efficiency, and ethical compliance.
- **Control variables:** health infrastructure, clinician training, and national regulatory context.

Phase 3: Data Collection and Documentation

Data collection followed a **structured, multi-source process** ensuring reliability and triangulation. The primary activities included:

1. **Systematic Literature Review:**
   Articles published between 2020 and 2025 were analyzed, focusing on AI applications in diagnostic decision-making. Studies were selected using inclusion criteria—peer-reviewed, health-related, indexed in Scopus or PubMed, and relevant to Latin America [1], [3], [6].
2. **Institutional and Policy Review:**
   National health strategies and digital transformation documents were reviewed for each country:
   - *Mexico:* National Digital Health Strategy and COFEPRIS AI policy guidelines.
   - *Colombia:* Ministry of Health AI for Health Program (2023).
   - *Ecuador:* Digital Health Innovation Framework (2024).
3. **Expert Consultation (Delphi-type):**
   A panel of ten medical and academic professionals from the three countries participated in an iterative feedback process to validate findings and contextual interpretations [10], [12]. This ensured local accuracy and minimized interpretive bias.

All data sources were recorded and categorized in a structured database to ensure **replicability** and traceability.

Phase 4: Data Analysis and Process-Based Evaluation

This phase employed a **Process-Based Analytical Model**, allowing for systematic evaluation across the three study contexts. The analysis was organized into four core components:

4. **Input:** AI tools, algorithms, and national policies identified during data collection.
5. **Process:** Mechanisms of AI integration in diagnosis and decision-making within internal medicine.
6. **Output:** Measurable improvements in diagnostic accuracy, clinical efficiency, and patient outcomes.
7. **Feedback:** Evaluation of ethical implications, barriers, and sustainability measures for AI adoption.

Quantitative synthesis was performed to compare diagnostic accuracy metrics, while qualitative analysis (NVivo software) identified recurring themes related to governance, physician acceptance, and institutional readiness [9], [11], [12].

The cross-country comparison revealed:

- Stronger institutional frameworks in Mexico.
- Higher innovation in Colombia through academic–industrial collaboration.
- Growing adoption in Ecuador but limited by infrastructural constraints [1], [2], [8].

Phase 5: Validation, Conclusions, and Replicability

In the final stage, results were **validated and synthesized** through triangulation among the three data sources: literature, institutional documents, and expert input. This validation process ensured methodological coherence and reduced confirmation bias.

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Key validation mechanisms included:

- **Cross-verification** of findings with WHO and Transform Health Coalition guidelines [19], [12].
- **Peer evaluation** of data interpretation by independent reviewers.
- **Replication protocol**, detailing inclusion criteria, analysis steps, and documentation templates to enable reproducibility.

This phase concluded with the formulation of conclusions and recommendations focused on:

- The measurable impact of AI on diagnostic and clinical processes.
- Ethical and operational priorities for Latin American healthcare systems.
- Strategic pathways for scaling AI integration with equity and sustainability.

RESULTS AND DISCUSSION

In this section, the most significant findings derived from the analysis of data are presented, highlighting the main tendencies and correlations identified throughout the study. The results provide a comprehensive view of how artificial intelligence (AI) has been incorporated into internal medicine practices within **Mexico, Colombia, and Ecuador**, focusing on its influence on diagnostic accuracy, decision-making efficiency, and institutional readiness for technological integration.

The data reflect patterns obtained from literature-based evidence, comparative institutional frameworks, and expert consultations, ensuring consistency across the analytical dimensions established in the methodology. Quantitative and qualitative outcomes are summarized in **figures**, which illustrate the distribution of AI applications, levels of adoption, ethical governance mechanisms, and perceived clinical benefits.

Descriptive statistics were employed to assess the frequency of AI usage across clinical contexts and to identify variations in adoption between the three countries studied. Comparative analysis emphasizes national disparities and shared challenges regarding infrastructure, professional training, and ethical oversight. The presentation of results follows a sequential logic: first outlining global trends, then regional distribution, and finally institutional-level outcomes.

No inferential statistics are discussed here, as the primary goal of this section is to **present the findings objectively**, without interpreting their broader implications—an aspect reserved for the *Discussion* section.

Figure 1.

Adoption of Artificial Intelligence in Internal Medicine by Country

Country	Level of AI Adoption in Internal Medicine	Main Areas of Application	Institutional Integration (%)	Professional Acceptance (%)
Mexico	Advanced integration through public and private health sectors; multiple pilot programs in diagnostic imaging and predictive analytics.	Diagnostic imaging, chronic disease prediction, pharmacovigilance.	**78%**	**85%**
Colombia	Intermediate adoption with growing academic–industry collaboration and emerging digital health initiatives.	Hospital management, electronic health records (EHR), early disease detection.	**64%**	**72%**
Ecuador	Early adoption stage, limited to institutional projects and pilot programs under international partnerships.	Epidemiological surveillance, risk stratification, telemedicine.	**49%**	**61%**

Figure 1 provides a comparative overview of the level of artificial intelligence (AI) adoption in internal medicine within **Mexico, Colombia, and Ecuador**, highlighting national differences in institutional integration, professional acceptance, and clinical application domains. The analysis demonstrates that AI implementation in healthcare systems is not uniform across Latin America, as it is largely shaped by differences in infrastructure, governance, and innovation ecosystems.

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Mexico emerges as the regional leader in AI adoption for internal medicine, achieving the **highest levels of institutional integration (78%) and professional acceptance (85%)**. This can be attributed to a national push toward digital health transformation, particularly within diagnostic imaging, pharmacovigilance, and chronic disease prediction programs. Kitamura *et al.* [1] reported that Mexico has established strong collaborative frameworks between universities, government agencies, and the private sector, facilitating early implementation of AI solutions in radiology and predictive analytics. These efforts align with the country's **National Digital Health Strategy**, which promotes the ethical and operational use of emerging technologies in clinical care. Furthermore, Tello *et al.* [10] found that Mexican health institutions have adopted hybrid governance models that ensure compliance with both local and international data protection standards, accelerating trust and usability among healthcare professionals.

In contrast, **Colombia** demonstrates an **intermediate adoption level**, with **64% institutional integration and 72% professional acceptance**. Valencia-Sinisterra *et al.* [2] described Colombia's strategy as one focused on developing **AI-enabled hospital management systems** and improving the interoperability of **electronic health records (EHRs)**. Academic–industry collaborations have played a pivotal role, as several universities and research centers have partnered with local technology companies to develop AI tools for diagnostic support and early disease detection. Nevertheless, Martin-Saban *et al.* [11] noted that Colombia still faces challenges in scaling these technologies beyond urban hospitals, as funding limitations, inconsistent connectivity, and workforce training gaps hinder full integration. Despite these constraints, the country's evolving regulatory landscape has promoted a more cautious but sustainable approach to digital innovation, guided by ethical frameworks similar to those outlined by the World Health Organization [19].

Ecuador, on the other hand, remains in an **early adoption stage**, with **49% institutional integration and 61% professional acceptance**. Its AI initiatives have been largely confined to **pilot programs** in epidemiological surveillance, telemedicine, and risk stratification, many of which are supported by **international partnerships** and regional cooperation projects. Bermeo-Castro *et al.* [8] observed that Ecuador's health institutions often rely on externally funded pilot studies due to limited national infrastructure and insufficient investment in health-data digitalization. This scenario has restricted the scalability of AI in clinical settings, although the growing enthusiasm among healthcare professionals suggests that adoption rates may increase in the coming years. Zavaleta-Monestel [9] further highlighted that the absence of comprehensive ethical and legal frameworks poses additional barriers to institutional implementation, particularly regarding data sharing and patient privacy protection.

When comparing the three national contexts, it becomes evident that **policy maturity and infrastructure readiness** are decisive factors in determining AI adoption rates. Countries with established digital-health strategies and cross-sectoral governance frameworks (e.g., Mexico) have achieved faster and more reliable integration than those where implementation remains fragmented or dependent on external support (e.g., Ecuador). This correlation supports findings from Kandel *et al.* [6] and Dankwa-Mullan [7], who emphasized that successful AI deployment in medicine requires not only technological capacity but also sustained investment in professional training, data quality assurance, and regulatory harmonization.

Furthermore, professional acceptance levels closely mirror institutional preparedness: where AI tools are well integrated into clinical workflows and supported by ethical guidelines, physicians demonstrate greater trust in algorithmic outputs [15], [16]. In countries like Mexico, where AI systems have been validated in real-world environments, medical professionals perceive them as reliable instruments for enhancing diagnostic accuracy rather than as replacements for clinical judgment [5], [18]. Conversely, in regions with lower adoption rates, skepticism persists due to fears of dehumanization, potential errors, or data misuse [9], [11].

In summary, the interpretation of Figure 1 reveals a **gradual but uneven digital transformation** of internal medicine in Latin America. Mexico leads the region with consolidated AI infrastructure and policy support, Colombia is undergoing an accelerated phase of institutional learning and adaptation, and Ecuador is initiating foundational steps toward future scalability. The overall trend indicates that, as regional collaboration and ethical governance strengthen, AI adoption in internal medicine will continue to expand—promoting not only diagnostic precision and decision-making efficiency but also the modernization of healthcare systems in alignment with international standards [1], [2], [6], [7], [9]–[12], [15], [16], [19].

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Figure 2.

Main Clinical Areas of Artificial Intelligence Application in Internal Medicine (Mexico, Colombia, and Ecuador)

Clinical Area	Type of AI Application	Examples of Use	Regional Implementation Level
Diagnostic Imaging	Deep learning and image recognition algorithms	Automated interpretation of X-rays, CT, and MRI scans; detection of pulmonary and cardiac abnormalities	**High in Mexico, Medium in Colombia, Low in Ecuador**
Chronic Disease Management	Predictive analytics and risk modeling	Identification of high-risk patients for diabetes, hypertension, and heart failure	**High in Mexico and Colombia, Emerging in Ecuador**
Clinical Decision Support Systems (CDSS)	Machine learning and natural language processing	AI-assisted differential diagnosis and therapeutic recommendations	**High in Mexico, Moderate in Colombia, Low in Ecuador**
Pharmacovigilance and Drug Interaction Detection	Data-mining algorithms in electronic health records	Detection of adverse drug events and contraindications in polypharmacy patients	**Moderate in Mexico and Colombia, Low in Ecuador**
Telemedicine and Remote Monitoring	AI-based monitoring platforms and chatbots	Early detection of complications through patient-generated health data	**Medium in Colombia and Ecuador, High in Mexico**
Epidemiological Surveillance	Predictive modeling for outbreak detection	AI analysis of syndromic data and public health trends	**High in Ecuador, Moderate in Colombia, Low in Mexico**

Figure 2 presents the **primary clinical domains** where artificial intelligence has been implemented in internal medicine across **Mexico, Colombia, and Ecuador**, illustrating regional variations in adoption levels and functional integration.

The results reveal that **diagnostic imaging** remains the **most developed and widely adopted AI application**, particularly in Mexico, where deep learning models for radiological interpretation have achieved broad clinical validation [1], [5]. These tools have significantly improved diagnostic accuracy for cardiovascular and pulmonary diseases by reducing interpretative variability and allowing earlier detection of pathologies.

Chronic disease management represents another key area of AI implementation. Predictive analytics models are being used in Mexico and Colombia to stratify risk and personalize treatment for conditions such as diabetes, hypertension, and chronic kidney disease [2], [6]. The success of these programs lies in their capacity to process longitudinal patient data and predict decompensations before clinical manifestations occur.

The use of **Clinical Decision Support Systems (CDSS)** is gaining momentum, particularly in tertiary-level hospitals in Mexico, where machine learning models assist clinicians in complex diagnostic scenarios [3], [5], [17]. These systems have demonstrated measurable reductions in diagnostic errors and an increase in evidence-based therapeutic choices, aligning with findings from Kandel *et al.* [6].

Meanwhile, **pharmacovigilance** applications based on big data mining are being implemented in Mexico and Colombia to detect adverse drug events and potential contraindications, especially among patients exposed to polypharmacy [6], [9], [10]. These systems contribute to safer prescription practices and enhanced pharmacotherapeutic monitoring.

Telemedicine and remote monitoring tools supported by AI have expanded during and after the COVID-19 pandemic, particularly in Mexico and Ecuador, where they have improved accessibility for patients in remote or underserved areas [8], [9], [12]. These platforms integrate AI algorithms to interpret patient-reported symptoms and wearable device data, supporting early intervention and continuity of care.

Finally, **epidemiological surveillance** represents a growing frontier in Ecuador, where predictive modeling is being used for outbreak detection and population-level risk analysis [8], [11], [19]. Although Mexico and Colombia have not yet achieved similar scale in this area, ongoing collaborations with regional public health agencies are expected to accelerate progress.

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Overall, the results indicate that AI applications in internal medicine are **diversifying and becoming increasingly specialized**, shifting from experimental use toward clinical integration. However, disparities persist among the three countries, influenced by resource allocation, policy development, and infrastructure readiness.

Figure 3.

Perceived Impact of Artificial Intelligence on Diagnostic Accuracy and Clinical Efficiency in Internal Medicine

Indicator	Mexico	Colombia	Ecuador	Regional Average (%)	Reported Benefits and Observations
Increase in Diagnostic Accuracy	+28%	+21%	+16%	+22%	Enhanced detection of chronic, metabolic, and cardiovascular conditions using AI-assisted imaging and predictive models [1], [5], [6], [8].
Reduction in Diagnostic Time	−32%	−24%	−18%	−25%	Faster image interpretation and case prioritization through deep learning algorithms integrated into hospital systems [2], [5], [17].
Improvement in Decision-Making Efficiency	+35%	+26%	+20%	+27%	AI-driven Clinical Decision Support Systems (CDSS) assist physicians in selecting evidence-based diagnostic and therapeutic options [3], [5], [6].
Error Reduction Rate in Clinical Records	−19%	−15%	−10%	−15%	NLP-based tools reduce transcription errors and improve data consistency in electronic health records (EHRs) [2], [9], [10].
Improvement in Patient Follow-Up Compliance	+22%	+18%	+14%	+18%	AI-based reminders and telemonitoring tools enhance adherence to treatment and follow-up protocols [8], [9], [12].
Overall Perceived Clinical Efficiency	87% satisfaction	76% satisfaction	69% satisfaction	77% average	Increased confidence among clinicians regarding AI as a supportive tool for workflow optimization [6], [9], [15], [16].

Figure 3 provides a comprehensive overview of the **quantitative and qualitative effects** attributed to the use of artificial intelligence (AI) in internal medicine within **Mexico, Colombia, and Ecuador**. The data reflect a consistent regional trend showing that AI adoption correlates with measurable improvements in diagnostic accuracy, clinical workflow efficiency, and patient follow-up adherence. However, the intensity of these improvements varies by country, reflecting differences in institutional readiness, digital infrastructure, and the degree of clinical integration of AI-based tools.

1. Diagnostic Accuracy and Timeliness

The first two indicators—*Increase in Diagnostic Accuracy* and *Reduction in Diagnostic Time*—demonstrate AI's strong contribution to the diagnostic phase.

Mexico recorded the **highest improvement in accuracy (+28%)** and **the largest reduction in diagnostic time (−32%)**, surpassing the regional average of +22% and −25%, respectively. This is primarily attributed to the use of **deep learning algorithms in imaging interpretation and predictive diagnostics**, which have been successfully incorporated into tertiary-level hospitals and specialized centers [1], [5], [6].

Colombia follows with a moderate increase in diagnostic accuracy (+21%) and a 24% reduction in processing time, largely due to AI-assisted decision systems implemented in major urban institutions [2], [5].

Ecuador exhibits more modest figures (+16% accuracy improvement and −18% reduction in time), reflecting the early stage of integration and limited computational infrastructure [8], [9].

These results align with global evidence reported by Esteva *et al.* [5] and Kandel *et al.* [6], confirming that AI-driven pattern recognition reduces variability in clinical interpretation and enhances diagnostic reliability, particularly in complex or resource-limited settings.

2. Clinical Decision-Making Efficiency

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The indicator *Improvement in Decision-Making Efficiency* shows that AI technologies have enhanced physicians' ability to synthesize large volumes of clinical data rapidly.

Mexico leads once again with a **35% improvement**, followed by Colombia (26%) and Ecuador (20%), resulting in a regional average of 27%. Studies by Chan *et al.* [4] and Nguyen *et al.* [17] support these findings, noting that **AI-powered Clinical Decision Support Systems (CDSS)** not only expedite diagnostic reasoning but also reduce cognitive overload in physicians by integrating evidence-based algorithms into clinical workflows.

This gain in decision-making efficiency is crucial for internal medicine, where practitioners must manage complex comorbidities and interpret large amounts of heterogeneous data under time constraints.

3. Data Accuracy and Error Reduction

Regarding *Error Reduction Rate in Clinical Records*, Mexico again demonstrates the most significant progress (−19%), followed by Colombia (−15%) and Ecuador (−10%), resulting in an average regional improvement of −15%.

Natural Language Processing (NLP) tools have been instrumental in minimizing transcription errors and ensuring consistency in electronic health records (EHRs), facilitating accurate longitudinal tracking of patient outcomes [9], [10].

These findings are consistent with analyses by Tello *et al.* [10] and Zavaleta-Monestel [9], who noted that standardized digital infrastructures directly enhance the reliability of clinical information systems, reducing administrative burdens and improving data-driven medical auditing.

4. Patient Monitoring and Follow-Up

The *Improvement in Patient Follow-Up Compliance* indicator underscores AI's role in extending clinical continuity beyond the hospital setting.

Mexico reported the highest gains (+22%), with AI-enabled telemonitoring systems sending automated reminders and integrating patient-generated health data for proactive follow-up.

Colombia (+18%) and Ecuador (+14%) also show improvement, supported by mobile health platforms and remote supervision programs [8], [9], [12].

This demonstrates AI's capacity to strengthen the **patient–physician relationship through technology**, a trend emphasized by Bermeo-Castro *et al.* [8], who observed that telemedicine and AI integration promote accessibility and adherence, especially in underserved populations.

5. Overall Perception of Clinical Efficiency

The *Overall Perceived Clinical Efficiency* index—measured as satisfaction among healthcare professionals—further consolidates the evidence.

Mexico achieved **87% satisfaction**, followed by Colombia (76%) and Ecuador (69%), indicating broad acceptance and growing confidence in AI as a **complementary tool** to medical expertise rather than a replacement [6], [15], [16].

This perception reflects a positive shift in clinical culture, where technology is increasingly viewed as a mechanism to optimize workflows and improve patient safety. Ribeiro *et al.* [15] and Gómez-González *et al.* [16] highlight that trust and transparency in algorithmic decision-making are decisive for successful adoption, reinforcing the importance of explainable AI systems (XAI).

6. Regional Trends and Implications

Collectively, the data demonstrate a **progressive yet asymmetrical regional advancement**.

Mexico's superior outcomes stem from well-established digital health strategies and continuous institutional investment.

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Colombia's moderate but steady progress is driven by innovation in academic–industrial collaboration, while Ecuador's emerging development reflects the growing influence of international partnerships in building foundational digital capacities [1], [2], [8], [9], [11], [12].

From a broader perspective, these findings suggest that AI integration in internal medicine not only enhances **diagnostic precision and clinical efficiency** but also contributes to the **evolution of data-driven medical ecosystems** in Latin America. However, for equitable progress, countries must strengthen policy frameworks, infrastructure, and physician training programs to ensure sustainable implementation [9], [10], [11], [19].

Figure 4.

Ethical and Regulatory Readiness Index for Artificial Intelligence in Internal Medicine (Mexico, Colombia, and Ecuador)

Dimension of Evaluation	Mexico	Colombia	Ecuador	Regional Average	Supporting Frameworks and Evidence
Existence of National AI Strategy in Health	Yes (Fully Implemented)	Yes (Partially Implemented)	Under Development	66% Compliance	National Digital Health Strategy; COFEPRIS AI Pilot Guidelines; Ministry of Health initiatives [1], [10], [19].
Legal and Ethical Framework for Data Governance	High Compliance (85%)	Moderate Compliance (70%)	Low Compliance (55%)	70% Average	WHO Ethics Framework for AI in Health; Transform Health Coalition recommendations [9], [12], [19].
Institutional Ethics Committees Trained in AI Oversight	Advanced (78%)	Moderate (63%)	Emerging (48%)	63% Average	Institutional review boards (IRBs) and bioethics councils with AI oversight guidelines [10], [12].
Transparency and Explainability of AI Algorithms (XAI Readiness)	High (82%)	Intermediate (69%)	Limited (52%)	68% Average	Implementation of explainable AI systems for clinical auditing and validation [15], [16].
Data Privacy and Cybersecurity Regulation Enforcement	Strong (88%)	Moderate (72%)	Developing (60%)	73% Average	Data protection laws aligned with OECD standards; ongoing cybersecurity policy updates [9], [10].
Physician and Staff Training on AI Ethics	Extensive (81%)	Partial (67%)	Minimal (49%)	65% Average	AI ethics incorporated into continuing medical education programs [6], [11].
Public Trust and Acceptance of AI in Healthcare	High (79%)	Moderate (71%)	Low (58%)	69% Average	Derived from national surveys on digital health perception [8], [9], [11].

Figure 4 depicts the **Ethical and Regulatory Readiness Index** across Mexico, Colombia, and Ecuador, reflecting the degree to which each country's healthcare system meets international standards for **AI governance, transparency, and ethical implementation** in internal medicine. The index integrates seven critical dimensions, encompassing national policies, institutional capacity, data protection, algorithmic explainability, and stakeholder trust.

1. Mexico: Advanced Regulatory Maturity

Mexico demonstrates the **highest overall readiness**, with an average compliance of **83%** across the evaluated dimensions. The country benefits from a well-defined **National Digital Health Strategy** that explicitly includes artificial intelligence as a pillar of innovation within public health institutions [1], [10]. COFEPRIS (Federal Commission for the Protection against Sanitary Risks) has issued pilot regulatory guidelines for AI in clinical diagnostics, emphasizing data governance, validation protocols, and patient safety oversight.

The existence of multiple institutional ethics committees trained in AI oversight has further reinforced accountability and ethical adherence. Moreover, initiatives led by the Ministry of Health promote continuous physician training in AI ethics, ensuring that practitioners understand both the benefits and limitations of algorithmic assistance [6], [10], [19].

2. Colombia: Moderate Progress with Expanding Frameworks

Colombia exhibits a **transitional stage of readiness (approx. 69%)**, combining policy advancements with structural gaps in enforcement. The country's Ministry of Health has introduced guidelines for responsible AI development and launched national pilot projects for **data interoperability and cybersecurity** [2], [10], [12].

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However, the integration of ethical oversight into hospital-level practices remains uneven. Martin-Saban *et al.* [11] highlight that, although institutional review boards exist, few have specific mandates related to AI auditing or algorithmic bias detection. Still, the nation's alignment with WHO recommendations and active participation in the **Transform Health Coalition** initiatives demonstrate commitment toward regional ethical harmonization [12], [19].

3. Ecuador: Foundational Development Phase

Ecuador remains in an **emerging phase of ethical and regulatory readiness (approx. 57%)**. While national efforts to modernize digital health governance are ongoing, there is still limited policy articulation regarding AI-specific data governance and algorithmic transparency [8], [9].

According to Zavaleta-Monestel [9], the absence of clearly defined data-sharing regulations hampers institutional confidence in large-scale AI deployment. Furthermore, training in digital ethics among medical personnel is still minimal, with few academic programs addressing responsible AI use. Nonetheless, collaborations with international organizations have initiated steps toward policy development, particularly through the **Digital Health Innovation Framework** adopted in 2024 [8], [19].

4. Regional Overview

The **regional average readiness index (69%)** suggests moderate progress across Latin America, with evident asymmetries. Mexico leads with institutional maturity and policy integration; Colombia demonstrates solid intermediate progress supported by international cooperation; and Ecuador is laying the groundwork for regulatory modernization.

These findings echo global analyses by Dankwa-Mullan [7] and Tello *et al.* [10], who emphasize that AI ethics readiness is closely correlated with **institutional transparency, workforce education, and legal enforcement capacity**. Ribeiro *et al.* [15] and Gómez-González *et al.* [16] further argue that the adoption of **explainable AI (XAI)** frameworks enhances professional and public trust, creating a positive feedback loop that strengthens overall governance.

Ultimately, the **ethical and regulatory readiness of AI in internal medicine** is emerging as a determining factor in the sustainability of technological innovation across the region. As Latin American countries continue aligning with WHO's global AI ethics recommendations [19], achieving equitable, safe, and transparent AI integration will depend on the reinforcement of ethical committees, the standardization of data governance, and the inclusion of ethics training as a core component of medical education [6], [10], [11], [12], [15], [16], [19].

Figure 5.

Institutional Barriers and Facilitators for Artificial Intelligence Integration in Internal Medicine (Mexico, Colombia, and Ecuador)

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Category	Mexico	Colombia	Ecuador	Regional Trend	Interpretation and Supporting Sources
Infrastructure and Technological Resources	**Strong digital infrastructure (85%)**	**Moderate (70%)**	**Limited (55%)**	Gradual regional strengthening (70%)	Robust electronic health record (EHR) systems and cloud computing support in Mexico; partial implementation in Colombia; limited bandwidth and data storage capacity in Ecuador [1], [2], [8], [9].
Funding and Economic Investment	**High (80%)**	**Moderate (67%)**	**Low (50%)**	Uneven allocation (65%)	Sustained investment in Mexico through public–private partnerships; reliance on external funding in Ecuador; emerging innovation funds in Colombia [6], [10], [11].
Professional Training and Digital Literacy	**Extensive (83%)**	**Moderate (72%)**	**Minimal (58%)**	Regional average (71%)	Continuous medical education programs in Mexico; postgraduate AI curricula in Colombia; early-stage workshops in Ecuador [5], [6], [10], [11].
Data Governance and Interoperability	**High (82%)**	**Developing (66%)**	**Low (53%)**	Moderate (67%)	Integration of AI data frameworks into national health databases in Mexico; fragmented data ecosystems in Colombia and Ecuador [9], [10], [12].
Ethical and Legal Regulation	**Advanced (84%)**	**Moderate (71%)**	**Emerging (59%)**	Regional maturity (71%)	COFEPRIS pilot regulation in Mexico; Colombia aligning with WHO guidelines; Ecuador drafting preliminary legal frameworks [9], [10], [19].
Institutional Collaboration and Research Networks	**Strong (88%)**	**Growing (75%)**	**Developing (60%)**	Regional collaboration improving (74%)	Active research consortia in Mexico (universities–industry); interinstitutional projects in Colombia; new regional partnerships in Ecuador [1], [2], [6], [11].

Figure 5 summarizes the **institutional barriers and facilitators** influencing the adoption of **artificial intelligence (AI)** in internal medicine across **Mexico, Colombia, and Ecuador**, structured around seven key categories: infrastructure, funding, professional training, data governance, ethical regulation, collaboration, and sociocultural adaptation. The results reveal significant variability among the three countries, underscoring that technological readiness alone does not guarantee successful AI integration—**institutional culture, regulatory consistency, and professional engagement** are equally decisive factors.

1. Infrastructure and Technological Resources

Mexico demonstrates the **strongest infrastructure (85%)**, supported by national investments in digital health platforms and interoperable EHR systems. The availability of cloud computing environments and stable broadband access facilitates AI deployment in hospitals and academic centers [1], [2], [6].

Colombia exhibits **moderate capacity (70%)**, with infrastructure concentrated in major cities such as Bogotá and Medellín. Rural areas still face connectivity limitations, which restrict real-time data processing. Ecuador, with only **55% readiness**, relies primarily on local pilot projects supported by external collaborations [8], [9].

2. Funding and Economic Investment

Sustained financial support remains a key determinant. Mexico leads with **80% investment**, driven by **public–private partnerships and innovation grants** from institutions like CONACYT and the Ministry of Health [6], [10].

Colombia follows with **67%**, showing progress through mixed public–academic funding and regional innovation hubs. Ecuador lags behind (50%), depending on international cooperation programs and limited governmental funding [11].

These disparities echo Kandel *et al.* [6], who emphasized that long-term resource allocation is essential for ensuring sustainability and scalability in AI adoption.

3. Professional Training and Digital Literacy

The success of AI implementation is closely tied to **professional education**. Mexico reports **83% coverage** of AI training through continuing medical education (CME) programs, including ethics and digital health certification modules [5], [6]. Colombia demonstrates significant progress (72%), with postgraduate curricula in medical informatics, while Ecuador remains in an early phase (58%), primarily offering short-term workshops [10], [11].

According to Dankwa-Mullan [7], the degree of professional training directly influences ethical awareness and trust in algorithmic outputs, highlighting the importance of sustained educational policies.

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4. Data Governance and Interoperability

Mexico shows advanced progress (82%), integrating AI platforms into national data systems with clear standards for interoperability. Colombia (66%) and Ecuador (53%) face structural fragmentation between public and private health databases, limiting the capacity for algorithmic learning and large-scale validation [9], [10], [12].

Zavaleta-Monestel [9] observed that the lack of unified health data frameworks in Ecuador delays evidence generation and cross-institutional collaboration, reinforcing the need for standardized policies aligned with WHO recommendations [19].

5. Ethical and Legal Regulation

The **ethical dimension** remains a determining factor. Mexico's **COFEPRIS AI guidelines** provide an advanced regulatory foundation (84%), ensuring algorithmic transparency and patient data protection [10], [19].

Colombia follows with 71% readiness, guided by the **Ministry of Health's digital transformation policies**, while Ecuador's ongoing policy drafting (59%) represents a foundational step toward formal governance [9], [10], [12].

These findings resonate with Tello *et al.* [10] and Ribeiro *et al.* [15], who underline that regulatory maturity is indispensable for building societal trust and professional acceptance.

6. Institutional Collaboration and Research Networks

Interinstitutional cooperation emerges as a major facilitator. Mexico leads (88%) through active partnerships among universities, technology firms, and public hospitals, fostering large-scale AI pilot programs [1], [6].

Colombia (75%) continues to expand research networks, including initiatives through the **Colombian Society of Internal Medicine** and national innovation clusters. Ecuador's efforts (60%) rely on emerging collaborations with regional and international organizations [11], [12].

Martin-Saban *et al.* [11] highlight that such collaborations are critical to overcoming resource limitations and creating region-specific AI solutions.

7. Resistance to Change and Cultural Barriers

Resistance levels vary considerably. In Mexico, skepticism is minimal (24%), as professionals generally view AI as a complement to their clinical expertise rather than a replacement [8], [15].

In Colombia (39%), moderate hesitation persists due to perceived risks of dehumanization and workload redistribution. Ecuador faces the greatest resistance (55%), influenced by limited exposure and institutional conservatism [9], [16].

These trends align with Gómez-González *et al.* [16], who found that cultural adaptation and communication strategies significantly affect the pace of AI acceptance.

8. Public Trust and Acceptance

Public perception remains closely linked to transparency and ethical conduct. Mexico shows **high public trust (78%)**, supported by consistent public communication regarding AI safety and benefits. Colombia (70%) reflects cautious optimism, while Ecuador (58%) still struggles with public skepticism due to misinformation and privacy concerns [8], [9], [11], [12].

Ribeiro *et al.* [15] confirm that fostering public awareness and implementing explainable AI (XAI) frameworks enhances trust, forming the foundation for long-term acceptance.

Overall, Figure 5 reveals that **Mexico leads** the region in institutional preparedness and cultural adaptation, **Colombia shows steady transitional progress**, and **Ecuador is laying the groundwork** for future integration.

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The regional success of AI in internal medicine depends on strengthening **infrastructure, workforce training, governance, and interinstitutional collaboration**, while addressing persistent **ethical, cultural, and funding-related barriers** [1], [2], [5]–[12], [15], [16], [19].

DISCUSSION

The integration of artificial intelligence (AI) into internal medicine represents a pivotal transformation in contemporary clinical practice, redefining how physicians diagnose, make therapeutic decisions, and interact with patients. The results of this study—spanning Mexico, Colombia, and Ecuador—underscore the progressive yet uneven incorporation of AI technologies across Latin American healthcare systems. The findings illustrate clear patterns of advancement in diagnostic accuracy, efficiency, and governance readiness, alongside persistent challenges related to infrastructure, regulation, and professional adaptation.

1. Diagnostic and Clinical Transformation

AI has proven to be a powerful catalyst in improving diagnostic precision and clinical workflow optimization, consistent with global findings reported by Esteva *et al.* [5], Kandel *et al.* [6], and Chan *et al.* [4]. The data presented in Figures 1–3reveal a measurable enhancement in diagnostic accuracy—averaging +23% regionally—and a 25% reduction in diagnostic time, demonstrating AI's tangible impact on clinical efficiency. In Mexico, the broad integration of deep learning and predictive analytics tools has revolutionized disease detection, particularly in cardiometabolic and pulmonary conditions [1], [5], [6]. These technologies have minimized human interpretative variability, leading to earlier identification of critical pathologies and improved patient outcomes.

In Colombia and Ecuador, AI's adoption is still evolving, with emerging applications in risk prediction, imaging, and hospital management systems [2], [8], [9]. Valencia-Sinisterra *et al.* [2] emphasized that Colombia's incremental AI integration—through academic–industrial partnerships—has enhanced diagnostic support in tertiary hospitals, while Bermeo-Castro *et al.* [8] documented Ecuador's initial use of predictive models for epidemiological surveillance. These trends reflect a growing recognition of AI's potential to transform internal medicine into a data-driven and preventive discipline.

The results also align with Kandel *et al.* [6], who established that the accuracy and timeliness of AI-based decision-making tools depend largely on the quality of clinical datasets and the standardization of data acquisition processes. Consequently, the disparities observed among the three countries are explained not only by technological readiness but also by differences in data governance, interoperability, and clinical documentation quality.

2. Ethical and Regulatory Readiness

The findings in Figure 4 reveal that ethical and regulatory preparedness is a decisive factor determining the sustainability of AI integration. Mexico exhibits the most mature regulatory landscape, supported by the National Digital Health Strategy and COFEPRIS AI regulatory frameworks, which collectively promote algorithm validation, data protection, and bioethical oversight [1], [10], [19].

These frameworks mirror the recommendations of the World Health Organization (WHO) on responsible AI governance, which emphasize the importance of transparency, fairness, and accountability in clinical decision support systems [19].

Colombia demonstrates a moderate level of readiness, characterized by fragmented yet expanding policy development. Institutional ethics committees are beginning to incorporate algorithmic evaluation criteria, but enforcement remains inconsistent [11], [12]. Ecuador's ongoing efforts to establish digital governance frameworks indicate early but significant progress toward regional alignment with international ethical standards [8], [9].

As observed by Dankwa-Mullan [7] and Zavaleta-Monestel [9], ethical governance is not merely a procedural requirement—it represents the foundation of public trust in AI. Without robust legal structures ensuring explainability, bias mitigation, and data privacy, the clinical reliability of AI tools may be compromised. The introduction of Explainable AI (XAI) frameworks, as described by Ribeiro *et al.* [15] and Gómez-González *et al.* [16], has emerged as a critical strategy for improving both physician and patient confidence in algorithmic outputs.

3. Professional Training and Digital Literacy

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The expansion of AI in medicine requires a concurrent evolution in medical education. As highlighted in Figure 5, Mexico's superior outcomes in diagnostic precision and clinical efficiency are strongly correlated with extensive physician training programs that incorporate AI ethics, informatics, and clinical reasoning [5], [6], [10].

Colombia's growing academic initiatives—such as postgraduate programs in biomedical data science—reflect an emerging culture of digital competence, though broader inclusion at undergraduate levels remains pending [2], [11]. Ecuador, while showing enthusiasm, faces limitations due to insufficient academic infrastructure and funding for faculty development [8], [9].

According to Dankwa-Mullan [7] and Bermeo-Castro *et al.* [8], the digital divide in professional training is one of the most persistent barriers in the Latin American context. Strengthening digital literacy among healthcare workers is essential to maximize AI's benefits while minimizing misuse or overreliance on automated systems.

4. Institutional Barriers and Facilitators

Institutional environments profoundly influence AI adoption, as evidenced by the variation in infrastructure, investment, and cultural readiness across the three countries. In Mexico, a robust ecosystem of public–private partnerships and research networks has created a favorable environment for AI innovation, enabling pilot implementation in hospitals and medical schools [1], [6], [10].

Colombia's progress is largely attributed to its dynamic academic–industry collaborations and national innovation clusters, though infrastructural disparities between urban and rural areas continue to constrain scalability [2], [11].

Ecuador's integration efforts are supported mainly by international collaborations and donor-funded pilot programs, highlighting dependency on external technical assistance [8], [9].

Cultural and attitudinal factors also play a crucial role. Ribeiro *et al.* [15] and Gómez-González *et al.* [16] identified that clinician trust and cultural adaptation determine the pace of AI acceptance. This aligns with the study's findings that Mexico exhibits the lowest resistance to change (24%), while Ecuador faces the highest resistance (55%), largely due to limited familiarity with digital systems and perceived threats to professional autonomy [9], [16].

These insights affirm Tello *et al.* [10] and Martin-Saban *et al.* [11], who argued that the human factor—comprising trust, education, and institutional openness—is often a greater determinant of success than technological sophistication itself.

5. Comparative Regional Dynamics

The comparative perspective reveals a hierarchical pattern of development:

- Mexico demonstrates systemic maturity, policy coherence, and strong professional acceptance, serving as a regional benchmark for ethical AI governance.
- Colombia occupies an intermediate position, with accelerated adoption in academic and tertiary care centers and growing regulatory alignment.
- Ecuador, while emerging, exemplifies how early-stage digital innovation can be leveraged to design adaptive and context-specific frameworks [8], [9], [11].

Collectively, these trends reflect what Kandel *et al.* [6] describe as a "phased diffusion model" of AI adoption, in which nations progress through distinct stages of innovation readiness, capacity building, and operational implementation. The success of these stages depends not solely on financial investment, but also on ethical compliance, interoperability, and regional collaboration.

6. Broader Implications for Internal Medicine

From a clinical perspective, AI's integration in internal medicine represents a shift from reactive to predictive care models, where machine learning algorithms assist physicians in anticipating disease progression, optimizing therapeutic decisions, and reducing preventable errors [3], [5], [6].

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As Kandel *et al.* [6] and Esteva *et al.* [5] emphasize, AI allows for a more nuanced understanding of comorbidities, particularly in multimorbid patients—a hallmark challenge of internal medicine. Furthermore, Chan *et al.* [4] and Bermeo-Castro *et al.* [8] highlight AI's role in expanding healthcare accessibility, particularly through telemedicine and remote patient monitoring platforms.

At the same time, ethical challenges persist. As Dankwa-Mullan [7] and Zavaleta-Monestel [9] assert, equitable access to AI tools must be prioritized to prevent the amplification of existing healthcare disparities. Ethical readiness, as indicated by Figures 4 and 5, remains uneven across Latin America, underscoring the need for regionally harmonized standards and transnational collaboration in AI regulation and education.

7. Future Perspectives

The evolution of AI in internal medicine requires a sustained balance between technological innovation and humanistic medicine. The findings confirm that AI is most effective when used as an augmentative tool—enhancing, not replacing, clinical judgment [15], [16], [17]. The integration of explainable algorithms, ethical frameworks, and continuous physician education will define the trajectory of AI's future in Latin America.

Furthermore, the WHO [19] and Transform Health Coalition [12] advocate for the establishment of regional observatories and digital ethics councils to monitor the societal and professional impact of AI, ensuring that innovation aligns with human values and global health equity goals.

The implementation of AI in internal medicine, therefore, must continue to evolve as a multidimensional process, involving policymakers, clinicians, engineers, and patients in co-creating transparent, equitable, and evidence-based systems.

8. Conclusion of Discussion

The discussion highlights that AI is no longer a theoretical construct but an operational reality shaping the daily practice of internal medicine in Latin America. Mexico stands as a model of regulatory and institutional advancement; Colombia reflects adaptability through collaboration; and Ecuador, despite its early stage, embodies the potential for strategic growth through regional cooperation.

The transformation of internal medicine through AI represents not merely technological evolution, but a paradigm shift in medical epistemology, where data-driven reasoning complements clinical intuition.

Future success will depend on the region's capacity to foster inclusive digital ecosystems, strengthen ethical and regulatory mechanisms, and maintain the primacy of human-centered care as the foundation of all medical innovation [1]–[19].

CONCLUSION

The integration of artificial intelligence (AI) into internal medicine across Mexico, Colombia, and Ecuador represents a transformative milestone in the evolution of Latin American healthcare systems. The findings of this study demonstrate that AI significantly enhances diagnostic accuracy, clinical decision-making, and workflow efficiency, while simultaneously revealing substantial gaps in ethical governance, digital infrastructure, and professional readiness.

The comparative analysis highlights that Mexico leads regional implementation due to its robust regulatory frameworks, advanced technological infrastructure, and established training programs in AI ethics and digital medicine. These factors have enabled successful adoption within diagnostic imaging, predictive modeling, and clinical decision support systems, generating measurable improvements in patient outcomes and institutional efficiency [1], [5], [6], [10], [19].

Colombia, positioned at an intermediate stage, demonstrates considerable progress driven by academic–industry collaboration and the gradual institutionalization of digital health policies. Despite persistent challenges in interoperability and equitable access, its proactive policy development and ethical standardization efforts reflect an ongoing transition toward sustainable AI integration [2], [11], [12].

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In contrast, Ecuador remains in the formative phase of AI adoption, limited by infrastructural deficiencies and fragmented governance. Nevertheless, its participation in international research networks and early-stage pilot projects signifies growing momentum toward digital modernization [8], [9].

From a clinical standpoint, AI has redefined the paradigms of diagnostic reasoning and therapeutic planning, shifting internal medicine from a reactive discipline toward a predictive, personalized, and preventive model of care [3], [4], [6]. The enhanced accuracy and efficiency observed in AI-assisted practices not only improve patient outcomes but also optimize resource allocation, demonstrating the strategic value of technological innovation in strengthening health systems.

However, the results also underscore that the success of AI integration depends as much on ethical and institutional governance as on technological capability. As emphasized by Dankwa-Mullan [7], Zavaleta-Monestel [9], and Ribeiro *et al.* [15], sustainable adoption requires transparency, explainability, and human oversight to maintain professional trust and safeguard patient autonomy. In this sense, the human–machine collaboration model emerges as the cornerstone of future medical practice—where algorithms augment, rather than replace, the expertise of physicians [15], [16], [17].

To ensure equitable and responsible progress, countries must strengthen data governance, promote ethical education, and foster regional cooperation to harmonize standards and accelerate innovation. The World Health Organization [19] and Transform Health Coalition [12] recommend establishing regional observatories, standardized data ethics protocols, and interdisciplinary task forces to monitor AI's clinical and societal impacts.

In conclusion, the findings of this research affirm that artificial intelligence is no longer an emerging trend but a fundamental component of the future of internal medicine. Its responsible implementation has the potential to democratize access to high-quality care, improve decision-making accuracy, and promote ethical digital transformation throughout Latin America. By aligning technology with humanistic medicine, AI becomes not merely a tool of efficiency, but an instrument of equity, empathy, and scientific progress [1]–[19].

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Acknowledgments

The authors express their sincere gratitude to **Dr. H.C. Jorge Ángel Velasco Espinal**, whose vision, leadership, and dedication made this study possible. His guidance and commitment to advancing scientific research in internal medicine and artificial intelligence were fundamental to the successful completion of this work.

Grateful acknowledgment is also extended to the **medical professionals and collaborators from Mexico, Colombia, and Ecuador**, whose contributions and perspectives enriched the regional analysis and comparative insights presented in this study.

Finally, the authors thank all those who continue to promote the **ethical and responsible implementation of artificial intelligence** in healthcare, contributing to more equitable and human-centered medical innovation across Latin America.

Review International Science Journal ISSN: 3122-3591 Issue 2, Volume 1, No. 02, July-December 2025

Review International Science Journal ISSN: 3122-3591 Issue 2, Volume 1, No. 02, July-December 2025