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Investment in Artificial Intelligence to Promote Public Health in the Middle East and North Africa: Current Status and Future Challenges

An Analytical Review

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INTRODUCTION: WHAT IS ARTIFICIAL INTELLIGENCE?

Artificial Intelligence (AI) is a foundational discipline within computer science concerned with the design and development of systems capable of executing tasks traditionally associated with human cognition. These tasks encompass reasoning, experiential learning, problem-solving, environmental perception, and natural language understanding. Rather than depending exclusively on pre-defined, rule-based programming, contemporary AI systems - through advanced machine learning methodologies - discern intricate patterns within heterogeneous datasets, including images, audio signals, and textual corpora, to perform classification, generate predictions, and detect subtle irregularities or anomalies.

This learning paradigm parallels the cognitive development of a child acquiring the concept of a "book." Through repeated exposure to numerous examples, the child progressively internalizes distinguishing features, enabling accurate recognition. This capacity emerges from the brain's neural architecture, wherein interconnected neural cells form increasingly complex and resilient networks that encode sensory experiences through repetition and reinforcement. Artificial intelligence systems operate through a comparable mechanism known as training, during which computational models are exposed to extensive volumes of data - textual, visual, and auditory - allowing them to abstract patterns and reliably generalize when presented with analogous inputs. In this sense, the training process bears resemblance to biological adaptation: the nature, scale, and diversity of the data fundamentally delimit and define the model's capabilities.

Scientific Foundations of Artificial Intelligence

Machine Learning (ML): A methodological framework enabling computational models to extract structure from data and iteratively enhance performance through exposure and experience, without necessitating explicit programming for each procedural step.

- **Supervised Learning:** The model is trained on labeled datasets with predefined outcomes, enabling predictive mapping between inputs and outputs.
- **Unsupervised Learning:** The model uncovers latent structures and relationships within unlabeled datasets, identifying patterns without prior outcome specification.
- **Reinforcement Learning:** The model refines its behavior through dynamic interaction with an environment, guided by reward and penalty mechanisms.

Neural Networks: Computational systems inspired by the structural and functional organization of the human brain, comprising interconnected layers of weighted nodes that process and transform data through hierarchical representations.

Deep Learning: An advanced subset of machine learning that leverages multi-layered neural network architectures to model complex, high-dimensional relationships, thereby enabling sophisticated tasks such as speech recognition and facial identification with notable precision.

With the expansion of its applications, artificial intelligence has transcended its initial characterization as a diagnostic adjunct to become an integral pillar in health data governance, predictive analytics, and the development of evidence-informed health policies. Within the Middle East and North Africa (MENA) region, AI assumes growing strategic relevance in response to multifaceted health challenges, including the escalating burden of chronic diseases, constrained

medical resources, and persistent inequities in access to specialized care. These systemic pressures have catalyzed accelerated interest in intelligent technologies as instruments for enhancing efficiency, optimizing resource allocation, and improving overall health outcomes.

Nevertheless, despite increasing recognition of its potential, the deployment of AI within healthcare systems across the MENA region remains comparatively limited in both practical and research contexts, particularly in clinical environments. Available evidence suggests that only a modest proportion of AI applications have transitioned from conceptual or experimental phases to sustained operational use in routine healthcare delivery. Furthermore, machine learning models aimed at forecasting sensitive health outcomes - such as pregnancy outcomes - remain sparse and geographically concentrated within select areas of the region. This discrepancy underscores a substantive gap between the transformative promise of AI and its tangible contribution to data-driven health policymaking. Addressing this gap necessitates expanded investment in applied research, institutional capacity development, and the establishment of enabling regulatory and technical frameworks to facilitate systematic integration into national health systems.

Concurrently, numerous countries in the region are advancing digital transformation agendas and constructing data-centric health infrastructures, thereby rendering the integration of AI-driven solutions not merely advantageous but strategically imperative. Such integration supports enhanced clinical decision-making, strengthens early diagnostic capabilities, and informs preventive strategies tailored to regional epidemiological realities. In this context, artificial intelligence is increasingly conceptualized as a strategic catalyst for advancing health sector development and reinforcing the long-term resilience and sustainability of health systems across the region.

Current Landscape: Predominant Emphasis on Curative Medicine and the Marginalization of Public Health, Policy Research, and Health Systems

The overwhelming majority of existing studies and reports concentrate on artificial intelligence applications within curative medicine. While this focus reflects a substantial portion of real-world technological deployment, it also reinforces a paradigm that overlooks a fundamental reality: sustained investment in public health yields greater long-term returns, not only in terms of improved population health outcomes, but also in enhanced economic efficiency. Expenditures associated with curative care, particularly amid growing reliance on advanced and high-cost technologies, significantly exceed those required to strengthen public health systems and expand their preventive capacities.

Against this backdrop, there is an urgent need to recalibrate the discourse toward the strategic role of artificial intelligence in advancing public health and informing health policy and systems research across the Middle East and North Africa (MENA) region. These technologies hold considerable potential to address escalating health challenges, reinforce preventive and predictive capacities, and move beyond the traditional emphasis on treatment-centered models of care.

Empirical and applied experiences in several countries across the region demonstrate that AI can assume a pivotal role in tackling priority health concerns. Notably, it has contributed to the development of more precise predictive models for non-communicable diseases, particularly cancer, diabetes, and other chronic conditions. AI applications have also gained traction in environmental health, especially in monitoring air pollution and forecasting its health impacts, thereby strengthening policymakers' ability to formulate evidence-based preventive strategies.

Importantly, the contribution of artificial intelligence extends beyond optimizing clinical

procedures or accelerating diagnostic processes. Its transformative potential lies in enabling structural shifts within healthcare systems, including early risk prediction, improved crisis responsiveness, and more efficient health resource management. This underscores the importance of embedding AI within national public health strategies and health policy frameworks as a supportive instrument for long-term planning and the sustainability of health systems across the region.

Despite this potential, the MENA region faces multiple barriers to the widespread adoption of AI-driven solutions in the health sector. A principal challenge lies in disparities in technological advancement among countries, with many still constrained by underdeveloped digital infrastructure. Egypt provides a salient example of this uneven progress. Although it is regarded as a major medical hub in the region, with approximately 1,782 hospitals nationwide, only 314 were operating electronic health record systems as of October 2024. This disparity illustrates the uneven and gradual pace of digital transformation within the health sector. In contrast, certain Gulf countries have demonstrated accelerated progress; the Dubai Health Authority, for instance, achieved a 98.55% digital completion rate across its health systems. Such divergence reflects a pronounced digital divide between countries with advanced infrastructures and those in earlier stages of transformation, an imbalance that constrains large-scale AI implementation.

Accordingly, strengthening foundational technological infrastructure has become a prerequisite for the effective deployment of AI solutions. Investment must first ensure the robust adoption of essential digital systems, followed by a phased and strategic expansion toward more advanced AI applications.

This report examines the current state of artificial intelligence utilization across the region, analyzes the principal challenges impeding its advancement, and proposes recommendations aimed at accelerating digital transformation within the health sector while enhancing the effective and strategic integration of AI technologies.

Historical Overview

Artificial intelligence research emerged in the 1960s with the primary aim of developing systems capable of emulating human intelligence. Early efforts led to expert-based systems in healthcare designed to support clinical decision-making in diagnosis and treatment planning. During the 1980s and 1990s, the field expanded significantly with advances in machine learning and natural language processing (NLP), enabling broader exploration of AI applications in disease diagnosis, drug discovery, and epidemiological surveillance—driven by the growing availability of large medical databases and improved computational capacity.

With the turn of the millennium, qualitative breakthroughs in computer vision - focused on enabling machines to interpret images in human-like ways - alongside advances in NLP and machine learning, allowed the development of more sophisticated and precise AI systems. These systems became capable of analyzing vast volumes of multimodal data and generating increasingly accurate predictions of future health outcomes.

In medicine and public health, AI-powered diagnostic systems were introduced, particularly in medical imaging analysis to support the detection of complex conditions such as cancer. Advances in text mining—the extraction of analyzable insights from large volumes of unstructured textual data—further enabled the use of AI in examining electronic health records and deriving meaningful clinical and policy-relevant insights. While these rapid developments reshaped clinical practice and healthcare management, AI's role expanded more prominently within public health, a shift that became especially evident during the COVID-19 pandemic, when its capabilities strengthened surveillance systems and rapid epidemic response.

Applications of Artificial Intelligence During the COVID-19 Pandemic

Area of Application	Description
Health Response Support	Strengthening health planning and decision-making
COVID-19 Diagnosis	Improving the speed and accuracy of case detection
COVID-19 Outbreak Surveillance	Epidemiological monitoring and early cluster detection
Contact Tracing	Identifying transmission chains and limiting viral spread
Countering Health Misinformation	Detecting rumors and inaccurate health information and mitigating their impact
Automated Screening	Conducting intelligent screening and early case identification
Transmission Forecasting	Modeling disease spread and predicting waves of infection
Severity Assessment	Anticipating complications and health outcomes at individual or population levels
Therapeutics Development	Accelerating pharmaceutical research and drug development
Drug Safety Monitoring	Tracking adverse effects and post-market treatment effectiveness
Health Resource Management	Optimizing allocation of medical and human resources

EXAMPLES OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN PUBLIC HEALTH

Predictive Modeling

Artificial intelligence is extensively applied in predictive modeling, an analytical approach designed to enhance forecasting accuracy and enable proactive decision-making through the analysis of health data. These models rely on advanced statistical algorithms and machine learning techniques to anticipate future public health trends, surpassing many of the limitations associated with conventional methods.

Applications include forecasting disease spread and epidemic outbreaks, as well as estimating health risks at individual and population levels. By analyzing large and diverse datasets - such as electronic health records, social media data, genomic information, and medical imaging - AI systems can detect complex patterns and predict the likelihood of disease onset or progression. This capability supports the identification of high-risk populations for conditions such as cardiovascular diseases and stroke, while enabling more targeted preventive interventions and more efficient allocation of health resources.

Spatial modeling represents a critical extension of predictive analytics, focusing on the geographic distribution of diseases and health risks. Through the integration of AI with Geographic Information Systems (GIS), highly localized forecasts can be generated, allowing for the identification of areas disproportionately affected by health threats - particularly in the context of climate change and shifting land-use patterns. Such models have been employed to map malaria and dengue risk, predict cholera outbreaks following floods, and inform immunization campaign planning.

AI also strengthens health surveillance and early warning systems by analyzing large-scale digital data streams, including online reports, news sources, and health facility records. Syndromic surveillance - based on triage notes, prescription patterns, and laboratory testing requests - facilitates the early detection of influenza waves, antimicrobial-resistant infections, and hospital-based outbreaks.

The field is poised for accelerated advancement as AI increasingly integrates with Internet of Things (IoT) technologies and wearable devices, which generate real-time data that enhance the timeliness and precision of predictions. Furthermore, the development of Explainable AI (XAI) is reinforcing transparency, accountability, and trust, critical elements for the responsible integration of predictive models into public health practice and health policymaking.

Electronic Health Records (EHR) and Health Data Analytics

The expansion of Electronic Health Records (EHR) has generated vast volumes of clinically valuable data for public health, including medical histories, laboratory results, prescriptions, and vital indicators. Artificial intelligence has enabled large-scale analysis of these datasets, uncovering patterns that often elude traditional analytical approaches.

Machine learning and Natural Language Processing (NLP) techniques are employed to extract insights from unstructured data—such as clinical notes and discharge summaries—supporting the prediction of health deterioration and the early detection of facility-based outbreaks. For example, analysis of prescription trends and laboratory requests can signal unusual increases in antimicrobial-resistant infections or respiratory illnesses.

At the systems level, AI-driven EHR analytics enhances health planning, performance evaluation, and the alignment of clinical care with broader public health objectives.

AI-Supported Medical Diagnosis

Medical diagnosis has undergone a substantive transformation through the integration of AI technologies in multimodal medical data analysis. These include Convolutional Neural Networks (CNNs), transformer-based models, and advanced NLP techniques applied to medical imaging modalities such as X-rays, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound.

This convergence has improved both diagnostic accuracy and speed, particularly in settings facing shortages of specialized expertise. Practical applications include tuberculosis detection from chest radiographs, diabetic retinopathy screening through retinal imaging, and enhanced interpretation of obstetric ultrasound scans. At the public health level, these advancements strengthen early case detection and improve the quality of data underpinning surveillance and health planning.

Disease Surveillance and Digital Epidemiological Monitoring

Artificial intelligence has become central to disease surveillance amid the exponential growth of data from both formal and informal sources, including electronic health records, social media platforms, and mobility and travel datasets. Digital epidemiology and infodemiology leverage these data streams to detect health trends, assess risk perceptions, monitor the spread of misinformation, and generate early warnings of potential outbreaks.

However, these applications face challenges related to data integration, variability in data quality, and the risk of bias when datasets fail to equitably represent diverse population groups, potentially leading to uneven resource allocation. Robust governance and transparency frameworks are therefore essential to ensure the responsible deployment of AI in public health contexts.

Health Planning, Resource Allocation, and System Performance Optimization

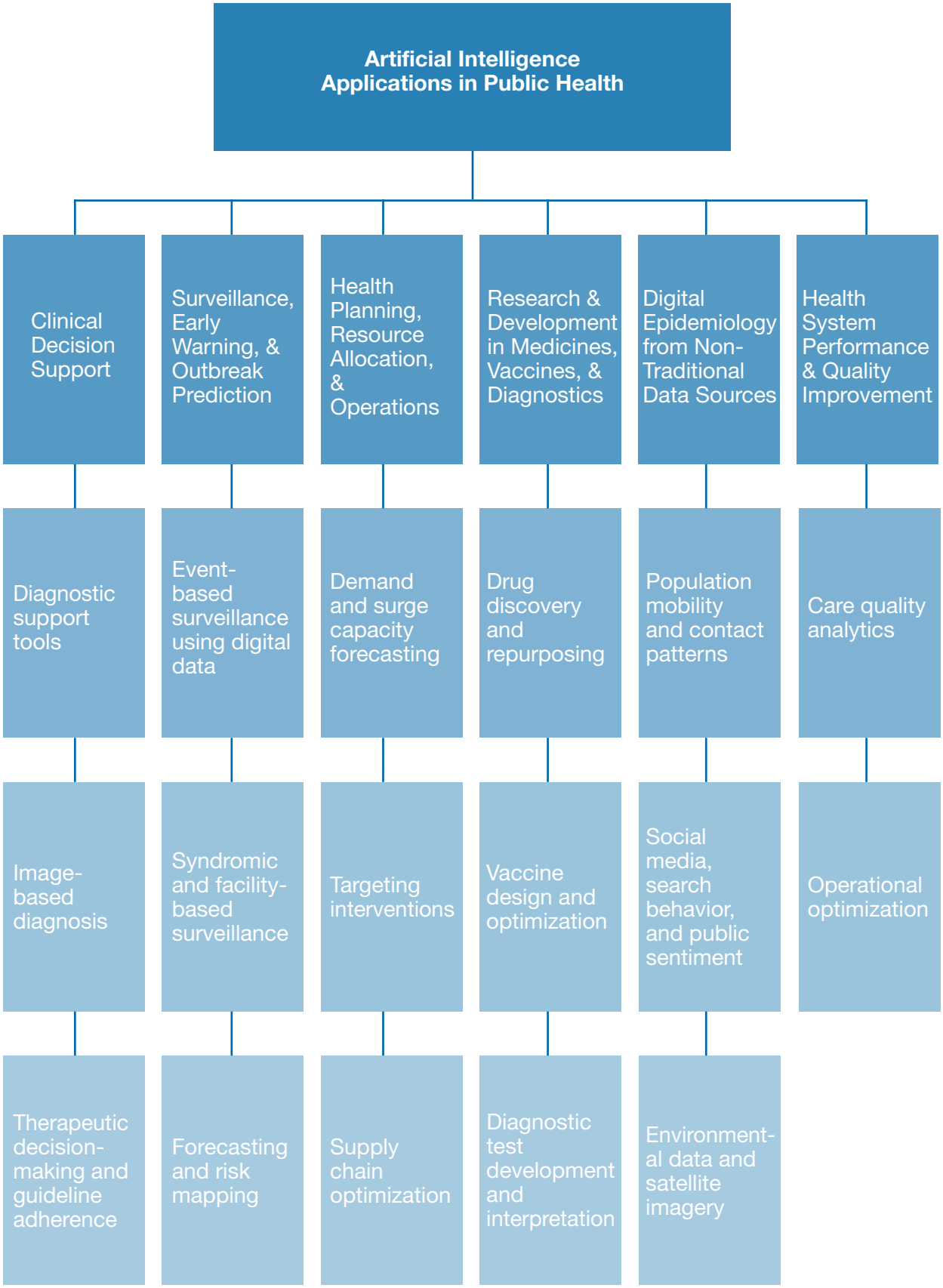
Artificial intelligence supports health planning by forecasting service demand and strengthening system surge capacity. This includes predicting needs for hospital beds, intensive care units, pharmaceutical supply chains, and healthcare workforce deployment, particularly during public health emergencies or epidemic peaks.

AI also contributes to system performance improvement through care quality analytics, identification of unsafe practices, and optimization of scheduling, patient flow, and referral pathways. Applications extend to targeted telemedicine deployment, prioritizing cases most likely to benefit, thereby enhancing resource efficiency and expanding access to care, especially in underserved and remote areas.

Research and Development in Medicines, Vaccines, and Diagnostics

AI plays an increasingly prominent role in accelerating research and development across pharmaceuticals, vaccines, and diagnostics. In drug discovery and repurposing, algorithms computationally screen extensive chemical libraries to identify promising compounds.

In vaccine development, AI facilitates antigen (epitope) prediction - identifying specific pathogen components capable of eliciting immune responses - thus supporting the design of more precise and effective vaccines. In diagnostics, AI enhances the design and interpretation of multiplex assays, which enable the simultaneous detection of multiple pathogens within a single test, thereby improving response speed and strengthening surveillance efficiency.


Artificial Intelligence Applications in Public Health
Clinical Decision Support
Surveillance, Early Warning, & Outbreak Prediction
Health Planning, Resource Allocation, & Operations
Research & Development in Medicines, Vaccines, & Diagnostics
Digital Epidemiology from Non-Traditional Data Sources
Health System Performance & Quality Improvement
Diagnostic support tools
Event-based surveillance using digital data
Demand and surge capacity forecasting
Drug discovery and repurposing
Population mobility and contact patterns
Care quality analytics
Image-based diagnosis
Syndromic and facility-based surveillance
Targeting interventions
Vaccine design and optimization
Social media, search behavior, and public sentiment
Operational optimization
Therapeutic decision-making and guideline adherence
Forecasting and risk mapping
Supply chain optimization
Diagnostic test development and interpretation
Environment-al data and satellite imagery

Artificial Intelligence in Public Health within Resource-Limited Settings (2025)

In recent years, artificial intelligence has emerged as a critical enabler of public health in low-resource settings. It helps mitigate shortages of healthcare professionals and facilities while expanding access to essential services such as immunization, antenatal care, and remote follow-up. Through widely accessible tools - such as WhatsApp-based applications or tailored digital platforms - communities can obtain health information and services more efficiently. The following 2025 examples illustrate diverse global applications:

Zimbabwe: An AI-powered WhatsApp chatbot, Nyamukuta, linked to portable blood pressure devices, supports pregnant women with antenatal guidance and self-monitoring, improving maternal health outcomes in underserved areas.

Nigeria: Platforms such as AwaDoc and Clafiya provide child health and immunization information via WhatsApp, addressing communication gaps in remote communities.

Mongolia: In collaboration with UNICEF, the eMongolia platform and the "Digital Mother and Child Health Book" enable mobile families to access health services, immunization records, and remote appointment scheduling—strengthening continuity of care and timely vaccination (UNICEF, 2025).

Non-English-Speaking Communities: Generative AI models assist researchers in scientific writing, simplifying complex concepts and enhancing accessibility for non-English-speaking audiences and resource-constrained contexts (Ratnam, 2025).

West and Central Africa: UNICEF's "Reach the Unreached" initiative employs machine learning and geospatial data to identify more than 1.3 million zero-dose children, guiding targeted immunization efforts and reducing equity gaps.

When contrasted with the Arab region, these experiences reveal substantial opportunities for adaptation. The United Arab Emirates, for example, has advanced AI-enabled health platforms such as Seha and the National Health Record system to facilitate service access and reduce coverage gaps. Conversely, resource-constrained countries such as Yemen and Sudan continue to face limitations in foundational digital infrastructure, widening regional disparities in digital health transformation.

Regionally, other Arab countries have achieved notable progress, particularly the Kingdom of Saudi Arabia, which—under Vision 2030—has established an advanced digital health infrastructure supporting AI integration. National platforms such as Sehhaty and Mawid, alongside integrated electronic health record systems and population-level health data analytics initiatives, contribute to preventive planning and system optimization. In contrast, politically stable yet resource-limited countries such as Jordan and Morocco have adopted AI solutions more cautiously in primary care settings, largely due to incomplete digital integration and fragmented health data systems.

These comparisons underscore the Arab region's capacity to draw from international experiences in resource-limited environments. Low-cost, scalable innovations - such as WhatsApp-based chatbots and simplified digital awareness platforms - demonstrate practical pathways to expand primary healthcare access. Adapting similar models within politically stable but resource-constrained Arab countries could strengthen public health capacity, improve service coverage, and accelerate equitable digital health transformation through flexible and cost-effective technological solutions.

The State of Artificial Intelligence in Public Health across the Middle East and North Africa

Recent studies indicate that documented applications of artificial intelligence within healthcare systems in the Middle East cluster around six principal themes, most prominently: (1) disease prediction and diagnosis, (2) climate-related forecasting, and (3) predicting workforce performance and satisfaction in healthcare settings. These themes recur across research published in multiple countries in the region.

Priority-setting studies further highlight AI's capacity to strengthen disease diagnosis and therapeutic recommendations. By analyzing large-scale datasets, AI systems have demonstrated the ability to detect complex patterns and, in certain contexts, outperform clinicians in diagnostic accuracy and treatment selection.

During the COVID-19 pandemic, AI technologies were deployed to reduce direct human contact and exposure risks, including through robotic assistance. They also supported screening, diagnosis, outcome prediction, case management, disease surveillance, contact tracing, drug discovery, and clinical decision support.
AI adoption has been particularly prominent in oncology services, underscoring its potential to address cancer-related challenges in a region where the disease constitutes a major public health burden.

Effective applications have also been documented in predicting diabetes, diabetic nephropathy, ulcers, and insulin resistance, an especially relevant development given that the Middle East bears the highest global prevalence of diabetes and the second-fastest growth rate worldwide.
AI has further demonstrated value in climate-related modeling and forecasting—an area of critical importance for a region highly vulnerable to extreme heat, declining precipitation, water scarcity, and related environmental stressors.

Despite these advances, recent literature reveals uneven AI adoption across MENA countries. Technology governance research notes that several states lack comprehensive data protection and privacy regulations, constraining the implementation of advanced digital health solutions. Digital readiness assessments point to substantial disparities in infrastructure investment and technological capacity. Gulf countries have advanced considerably through national strategies and sustained funding for digital transformation, though reliance on "soft regulation" may limit enforceability in sectors requiring stringent oversight, such as healthcare. Jordan, by contrast, is often cited as a middle-income example that has introduced national ethical frameworks.

Field studies from countries such as Egypt highlight how limited EHR coverage and fragmented large-scale datasets impede the development of robust diagnostic and predictive models. Additional research suggests that limited model interpretability reduces healthcare professionals' trust in AI tools. Meanwhile, studies from North African countries, including Morocco, indicate emerging AI ecosystems without fully integrated national strategies—creating a gap between innovation and regulatory alignment, particularly in health data applications. Collectively, the evidence shows that barriers extend beyond technical constraints to encompass legislative frameworks, data availability, and workforce capacity, reinforcing the persistent divide between Gulf states and other countries in the region.

The 2024 Global Index on Responsible AI (Corrected Edition) further illustrates marked regional disparities across governance, rights, transparency, capacity-building, and public participation dimensions. Western Europe and North America achieved the highest regional averages, with countries such as the United Kingdom, Canada, and the United States scoring comparatively high—often exceeding 70 out of 100 in governance and transparency indicators—supported by mature regulatory frameworks, including the European Union AI Act, and established oversight

mechanisms. By contrast, the Middle East and North Africa recorded below-global-average performance, with scores generally concentrated in the low-to-mid range, reflecting comparatively limited specialized regulatory frameworks.

Under the Governance and Regulation dimension, the Index indicates that European countries such as Germany and France achieved high scores, supported by clearly articulated legislation, dedicated oversight bodies, and detailed national frameworks for responsible AI. Within the Middle East and North Africa (MENA) region, certain Gulf states - notably the United Arab Emirates and the Kingdom of Saudi Arabia - demonstrate comparatively stronger regional performance, driven by ambitious national AI strategies and centralized governmental initiatives. However, their scores in this dimension remain below those of Western European counterparts. The report notes that many MENA countries rely primarily on broad strategic documents without translating them into binding legal frameworks or enforceable mechanisms, limiting governance effectiveness relative to jurisdictions with mature regulatory systems.

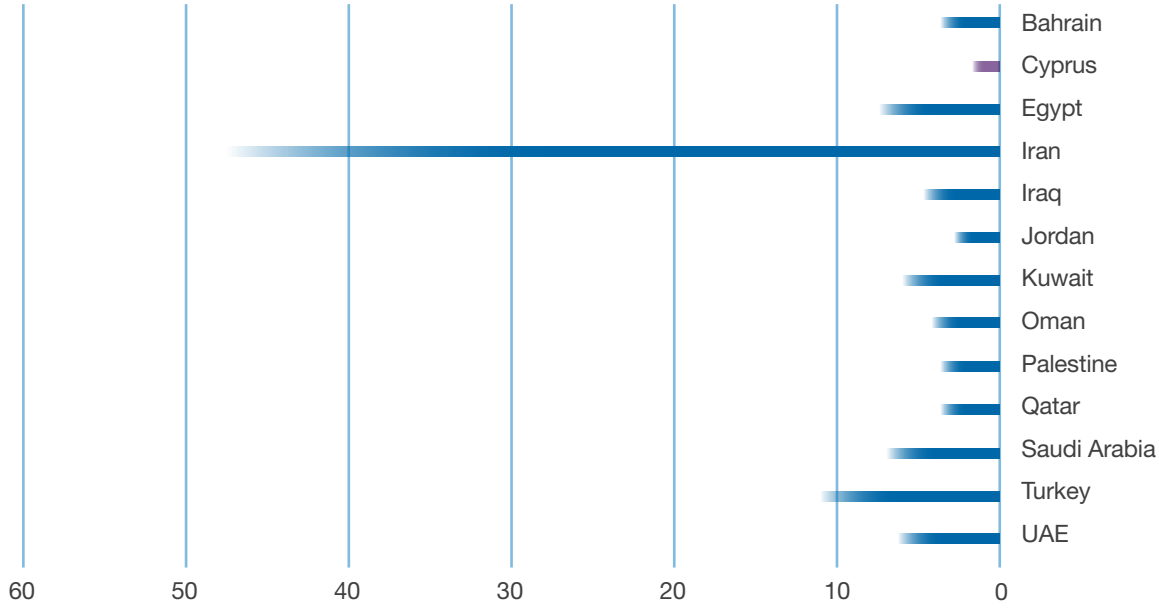
In the Transparency and Accountability dimension, countries such as Canada and the United Kingdom rank highly, reflecting established disclosure requirements, impact assessments, and structured stakeholder engagement processes. By contrast, most MENA countries record lower scores, with notable intra-regional variation. Although some have introduced preliminary ethical guidelines for AI, disclosure practices, risk assessment procedures, and institutional redress mechanisms remain limited or inconsistently applied, contributing to comparatively modest regional performance in this area.

The Capacity and Research Ecosystem dimension reveals a pronounced gap between MENA and leading regions such as East Asia, Europe, and North America. Countries including the United States, South Korea, and Germany benefit from advanced research infrastructures and sustained funding, resulting in strong performance indicators. In contrast, most MENA countries score lower due to limited specialized research programs in AI governance and ethics, as well as weak long-term institutional partnerships between academia, government, and the private sector. The report further observes that the region continues to rely largely on imported technologies rather than domestic innovation, constraining the adaptation of AI tools to local legal and social contexts.

Overall, the report concludes that the disparity between MENA and higher-performing regions is not merely a matter of AI adoption rates, but fundamentally reflects the maturity of institutional and regulatory frameworks governing responsible AI. While some MENA countries have achieved relative regional progress, the overall regional average remains below that of Europe, North America, and East Asia. Bridging this gap will require moving beyond strategic vision statements toward enforceable legislation, strengthened transparency mechanisms, and expanded investment in research and institutional capacity-building - thereby aligning more closely with international standards for responsible AI governance.

Themes of Published Studies on AI Applications in Healthcare Improvement in MENA

Prediction of organizational factors and characteristics	Disease prediction, diagnosis, and outcome modeling
Predicting medication overuse and conducting sentiment analysis of textual data	Forecasting mental health conditions and associated traits
Predicting and evaluating workforce success and satisfaction in healthcare settings	Climate change-related forecasting and associated variables



Regional Developments: The Gulf States as an Emerging Global Benchmark

In recent years, Gulf countries have witnessed an unprecedented acceleration in the integration of artificial intelligence within the health sector, driven by ambitious national visions and substantial strategic investments. This transformation encompasses advanced applications in early diagnosis, personalized treatment, robotic surgery, and virtual care. Collectively, these efforts are enhancing service quality, optimizing resource management, and strengthening the resilience of health systems to future challenges.

Kingdom of Saudi Arabia

Under Vision 2030, the Kingdom of Saudi Arabia has positioned artificial intelligence as a central pillar of national transformation, economic diversification, and the development of a knowledge-based economy—placing the country among emerging global leaders in innovation. The Riyadh Declaration underscores AI's critical role in advancing digital inclusion, expanding knowledge access, addressing global challenges, and generating economic value.

In alignment with this agenda, Saudi Arabia launched Project Transcendence, a landmark initiative backed by a $100 billion investment to establish a global AI technology hub. Recognizing that high-quality data is foundational to AI-enabled healthcare, the Kingdom established the National Data Bank (NDB) and the Saudi Data and AI Authority (SDAIA) to centralize and govern data across sectors, including health, thereby enabling scalable, data-driven innovation.

Key Achievements

Application / Entity	Area of Use	Quality Performance Indicators	Readiness Level
MiniGPT-Med (KAUST & SDAIA)	Multi-disease diagnosis; medical reporting	BERT-Sim / CheXbert-Sim: ≈ +19-point improvement (published) • Human clinical evaluation: 76% high-quality reports (published) • No published AUC / Sensitivity	Moderate

King Faisal Specialist Hospital	Oncology; genomic medicine	-	High
Eyenai	Diabetic retinopathy	Sensitivity / Specificity (applied) • AUC (applied) • Comparable global models: AUC ≈ 0.85–0.90 • National values unpublished	High
Seha Virtual Hospital & Lunit	Breast cancer; tuberculosis	-	High
KACST	Brain tumors	-	Moderate

Medical AI models are evaluated using performance metrics tailored to task type. Classification and detection models typically rely on AUC, sensitivity, and specificity; image segmentation tasks use Dice score and Intersection over Union (IoU); while multimodal and language-based medical models are assessed through textual similarity metrics (e.g., BERT-Sim, CheXbert-Sim), complemented by structured clinical human evaluation. Rigorous clinical validation and benchmarking against specialist performance remain essential prerequisites before large-scale implementation.

United Arab Emirates

The UAE healthcare sector is undergoing a profound transformation, with artificial intelligence playing a central role in enhancing patient care and redefining standards of medical innovation. From AI-driven tools that enable faster and more precise diagnosis through medical imaging and genomic analysis, to the integration of robotic surgery and personalized medicine, AI is streamlining treatment pathways and improving clinical outcomes nationwide.

Virtual health assistants and chatbots provide 24/7 support, enabling patients to manage symptoms, schedule appointments, and access reliable medical guidance—particularly in remote areas. At the national level, predictive analytics are deployed to monitor and prevent disease outbreaks, including COVID-19 and diabetes, thereby strengthening public health planning.

AI applications are also advancing mental health care through platforms that offer emotional support and monitor mood patterns while safeguarding privacy. These achievements are propelled by government-led initiatives such as the Dubai Health Authority's Smart Health Strategy and strategic partnerships with global technology firms. Simultaneously, the UAE is addressing ethical considerations by developing transparent policies that protect data privacy and promote fairness, reinforcing public trust in the health system.

The country is positioning itself as a global leader in medical technology (MedTech), with advanced solutions reshaping healthcare delivery across Abu Dhabi, Dubai, and beyond.

Key Achievements:

- **AI Integration:** The Department of Health – Abu Dhabi employs AI for early detection of chronic conditions, including diabetes and cardiovascular diseases.
- **Robotic Surgery:** Hospitals in Dubai, such as Mediclinic City Hospital and American Hospital Dubai, perform robot-assisted procedures with greater precision, reduced invasiveness, and faster recovery times.
- **Medical Innovation:** At Arab Health 2025, the UAE showcased advanced technologies including wearable devices, telemedicine platforms, and digital patient management systems.

- **Okadoc:** A widely adopted digital platform providing appointment booking, teleconsultations, and electronic record management across UAE healthcare facilities.

Dubai Health has also launched the ALiF Framework for AI Literacy, the first comprehensive regional framework aimed at enhancing AI understanding across professional environments, reflecting Dubai's sustained commitment to innovation and capacity development (Government of Dubai, 2025).

In Abu Dhabi, the Health, Endurance, Longevity, and Medicine (HELM) cluster was introduced as a strategic initiative to accelerate life sciences innovation through AI and big data. Led by the Abu Dhabi Investment Office (ADIO) in collaboration with the Department of Health – Abu Dhabi and the Department of Economic Development – Abu Dhabi, and in partnership with the Mohamed bin Zayed University of Artificial Intelligence (MBZUAI) and Hub71, HELM seeks to:

- Accelerate scientific research and drug discovery
- Advance data-driven personalized medicine
- Strengthen innovation infrastructure
- Develop and protect intellectual property
- Commercialize biotechnological innovations

The initiative also aims to attract global life sciences startups, fostering investment, skills development, and training, while consolidating Abu Dhabi's position as a regional hub for AI-driven health innovation.

Bahrain

Bahrain has achieved notable progress in healthcare technology, particularly in genomic medicine and robotics. The country has doubled its genome sequencing capacity to reach 20,000 whole genomes annually, aligning with national genome initiatives similar to those implemented in the United Arab Emirates and Saudi Arabia.

During the COVID-19 pandemic in 2020, Bahrain became the first Gulf country to deploy robots in healthcare settings. These were used for sterilization, medication delivery, and transport of heavy equipment. Thermal imaging cameras and facial recognition technologies supported remote monitoring and personalized care, reducing healthcare worker exposure to infection by approximately 80%.

The country is now planning to expand the use of robotics in nursing care to protect staff from exposure to hazardous chemicals and to improve efficiency by automating routine tasks. Bahrain has also expanded telemedicine services through applications such as BeAware and Sehati, leveraging its strong IT infrastructure to support the integration of digital health records for citizens.

Kuwait

At Jaber Hospital in Kuwait, artificial intelligence has been integrated into a range of medical applications, including surgery, endoscopic procedures, cardiac monitoring, and robotic-assisted operations. In 2023, surgeons introduced advanced three-dimensional imaging systems to generate detailed visualizations of internal organs, enhancing surgical precision. This marked the first deployment of Olympus technology of this kind in the Gulf region.

Kuwait also performed its first AI-assisted endoscopic surgery to accurately detect colon and

gastric tumors that might escape visual identification, reflecting growing adoption of advanced medical technologies.

The Gulf experience demonstrates that AI integration in healthcare depends not only on technological availability, but on clear national vision, sustained investment, and centralized data infrastructures capable of supporting efficient model training. Other countries in the region can draw lessons from this approach by strengthening coordination between healthcare and research institutions, developing unified health databases, and implementing robust data governance frameworks. The Gulf model further highlights the importance of international academic and technological partnerships in transferring expertise and building domestic capacity. Ultimately, the convergence of political commitment, regulatory maturity, and sustainable financing remains decisive for achieving transformative progress in AI-enabled healthcare.

Challenges Posed by Artificial Intelligence in Public Health

Ensuring data protection and privacy security is fundamental to the responsible deployment of artificial intelligence in public health. While the aggregation of patient data from multiple centers is often indispensable for developing robust and generalizable AI models, safeguarding confidentiality and data integrity remains paramount. These challenges encompass ethical and legal dimensions, particularly regarding data protection, as well as concerns about algorithmic bias and discrimination that may disproportionately affect vulnerable populations.

The accuracy and reliability of AI-driven systems are inherently dependent on the quality and completeness of the data used for training. In parallel, limited transparency and interpretability remain significant barriers to implementation. Policymakers may struggle to understand how algorithms generate conclusions, reinforcing skepticism and constraining wider adoption in public health settings.

In response to these concerns, the World Health Organization has articulated six guiding principles for the ethical use of AI: protecting autonomy, promoting well-being and safety, ensuring fairness, fostering transparency, upholding accountability, and advancing sustainability and inclusiveness. The WHO has also designated a collaborating center at Delft University of Technology to support the development of global governance standards for health-related AI.
Recent regional experiences demonstrate that ethical and technical challenges are not merely theoretical. During the COVID-19 pandemic, certain health tracking applications in Middle Eastern countries - particularly those relying on geolocation and health status data - sparked public debate regarding privacy safeguards, sensitive data management, and clarity of data use mechanisms. These cases underscored the need for stronger oversight frameworks, especially for high-sensitivity health applications.

To address such concerns, several countries have introduced national initiatives aimed at strengthening trust and transparency. In Saudi Arabia, for example, the establishment of the Saudi Data and AI Authority (SDAIA), alongside dedicated privacy protection programs, has introduced clearer standards governing health data collection and use. These frameworks require healthcare entities to adhere to unified security protocols and mitigate risks of bias or misuse. Such measures exemplify regional efforts to create a secure and accountable environment for AI in health, balancing innovation with the protection of patient rights.

Global Efforts to Safeguard Health from AI-Related Risks

In response to emerging challenges, many countries are developing robust regulatory and oversight frameworks that clearly define supervisory roles, accountability mechanisms, and standards for the ethical development, deployment, and evaluation of AI in healthcare. To support global alignment, the World Health Organization (WHO) issued comprehensive guidance following a two-year consultative process led by its Science Division, particularly its departments of Digital Health and Innovation and Research for Health. In collaboration with 20 international experts, WHO articulated six core principles for the ethical use of AI in health:

1. Protect autonomy.
2. Promote human well-being and the public interest.
3. Ensure transparency and explainability.
4. Foster responsibility and accountability.
5. Guarantee inclusiveness and equity.
6. Advance sustainability and responsiveness.

Beyond these principles, WHO outlines key strategies for responsible AI integration:

Leadership, expertise, and governance: Establish clear ethical, regulatory, and oversight frameworks.

1. Standards and testing: Implement protocols to verify safety and effectiveness.
2. Workforce development: Train health professionals in the use of AI tools.
3. Evidence-based research: Support studies assessing feasibility and impact.
4. Localization: Adapt models to diverse cultural and health contexts.
5. Community engagement: Create platforms for dialogue, collaboration, and knowledge exchange among stakeholders.

WHO has designated the Digital Ethics Centre at Delft University of Technology (Netherlands) as a Collaborating Centre for AI Governance in Health. This designation reflects the Centre's leadership in responsible innovation and ethical technology design. Collaboration has included international consultations, workshops, development of standards and guidance, and capacity-building initiatives. Through programs such as the Responsible and Ethical AI in Healthcare Lab, the Centre contributes to translating global guidance into practical clinical implementation. WHO officials have emphasized that such partnerships are critical to ensuring AI is deployed ethically, transparently, and equitably to advance global health outcomes.

AI Governance in the Middle East

The United Arab Emirates and Saudi Arabia have made significant progress in establishing structured ethical governance frameworks for AI in health, emphasizing transparency, fairness, and data protection. While their principles broadly align with WHO guidance, the Organization maintains a universal human rights–based approach, whereas Gulf states place additional emphasis on national priorities, cultural considerations, and regulatory flexibility, particularly during emergencies.

Gulf countries such as Saudi Arabia, Qatar, and the UAE are regional leaders in issuing AI-specific health guidance and regulations. In 2023, the Global AI Index ranked the UAE, Saudi Arabia, and Qatar as the top three Arab countries in investment, innovation, and AI deployment.

United Arab Emirates

Established a dedicated Ministry and Council for Artificial Intelligence and Blockchain in 2017. Implements a phased strategy grounded in strict governance and laws on data protection, cybersecurity, and electronic transactions.

Ethical AI principles include fairness, transparency, accountability, safety, privacy, and human-centricity.

Requires healthcare AI applications to be bias-free, socially beneficial, and compliant with national and international law.

Mandates ongoing performance monitoring, adverse event reporting, and clinician override mechanisms.

Saudi Arabia

Launched the Saudi Data and AI Authority (SDAIA) and the National Strategy for Data and AI (NSDAI).

Seeks to foster a flexible, innovation-driven environment anchored in strong ethical foundations. Balances technological advancement with strict data protection in sensitive sectors, particularly health.

Ethical principles include integrity, fairness, privacy, transparency, and alignment with Saudi cultural values.

Classifies health, genomic, and ethnic data as sensitive, requiring anonymization, encryption, or tokenization safeguards.

In contrast, North African countries display varying degrees of regulatory maturity. In Egypt, while progress has been made toward a national AI strategy and digital transformation bodies, legislation governing health and genetic data protection remains under development and largely general in scope, lacking detailed provisions tailored to AI-enabled medical applications.
Health institutions also face challenges in data standardization and transparency regarding model training processes.

In Morocco, personal data protection frameworks have advanced through the National Commission for the Control of Personal Data Protection. However, AI-specific policies in the health sector remain incomplete, and the absence of a comprehensive framework defining developer responsibilities and safeguards against algorithmic bias persists.

This comparison highlights a structural divergence: Gulf countries tend to adopt comprehensive, sector-specific strategies supported by dedicated government entities and explicit accountability mechanisms, whereas North African states are still consolidating broader data governance legislation without specialized regulatory instruments for health AI. Accelerating the development of targeted AI governance policies in North Africa will be essential to ensure safe, responsible, and context-sensitive deployment of these technologies.

Operationalizing AI in the Middle East and North Africa: Practical and Context-Sensitive Recommendations

Evidence indicates that multiple structural barriers continue to constrain AI adoption in healthcare across the region, including weak digital infrastructure, fragmented or low-quality data, limited data availability, insufficient workforce training, and the need to strengthen awareness and acceptance among providers and patients.

First, careful attention must be given to assessing the broader state of digital health across the Middle East and North Africa. Before advancing toward sophisticated technologies such as AI, substantial gaps in the adoption of even basic public health technologies must be acknowledged. In several countries, essential systems - such as electronic health information and surveillance platforms - remain underdeveloped or paper-based. Progress toward advanced AI integration is unlikely to be sustainable without first establishing these foundational digital capacities.

While more advanced countries in the region have moved decisively toward modern technologies - positioning themselves competitively at the global level - this divergence raises legitimate concerns regarding health equity. Low-income and conflict-affected countries, which often stand to benefit most from scalable innovation, risk exclusion due to limited resources and fragile infrastructure.

A regional assessment of readiness, drawing on WHO Eastern Mediterranean country profiles and official national strategies, reveals substantial variation in digital maturity. Gulf Cooperation Council (GCC) states - including the United Arab Emirates, Saudi Arabia, Qatar, and Bahrain - demonstrate advanced digital health ecosystems marked by widespread electronic health record (EHR) adoption, national AI strategies, and active clinical AI deployment.

By contrast, middle-income countries such as Egypt, Jordan, Tunisia, and Morocco display moderate readiness, characterized by partial EHR implementation and gradually expanding national initiatives. Meanwhile, conflict-affected and fragile states - including Yemen, Syria, Somalia, Afghanistan, Libya, and Sudan - exhibit very limited digital infrastructure and minimal AI integration.

These disparities underscore a tangible risk: rapid AI expansion without parallel investment in governance, infrastructure, and human capital may deepen existing health inequities. Aligning national AI policies with WHO guidance is therefore critical to ensure safe, equitable, and transparent deployment.

Digital Health and AI Readiness in MENA Countries

Country / Region	Digital Health & AI Readiness Status
United Arab Emirates	National AI strategy; widespread EHR adoption; active clinical AI applications
Saudi Arabia	Health Transformation Program; national EHR systems; clinical and research AI projects
	Advanced digital health systems; integrated EHR; health data initiatives
Bahrain	EHR integration; health information exchange; telemedicine expansion

Kuwait	Moderate progress in EHR and digital health
Oman	National digital health strategy; gradual EHR expansion
Eygpt	Partial EHR adoption
Jordan	National health information systems; gradual digital expansion
Lebanon	Limited progress due to economic crisis
Iraq	Low–moderate readiness; pilot projects
Iran	National health information infrastructure; limited AI use
Sudan	Low readiness; limited digital health adoption
Libya	Weak digital infrastructure due to conflict
Syria	Very low readiness
Yemen	Very low readiness
Tunisia	Moderate digital health infrastructure; EHR projects
Morocco	National digital health strategy; expanding EHR
Algeria	Partial digital health adoption
Afghanistan	Very low readiness
Pakistan	National health information systems; increasing digital adoption
Djibouti	Low readiness
Somalia	Very low readiness

The World Health Organization notes that data security and privacy remain persistent challenges at the global level. Regionally, these concerns are amplified, as communities are often not meaningfully engaged in policy development, oversight, and accountability processes, leaving citizens insufficiently protected with respect to privacy and confidentiality. Given that nearly half of the countries in the region are affected by social conflict or protracted emergencies, it is unsurprising that national capacities for managing digital health are weakened, whether in terms of technical workforce development or the establishment of adequate digital and physical infrastructure and equipment.

Digital health governance across much of the region remains either weak or fragmented, reflecting broader deficiencies in strategic planning. Systematic reviews and regional studies further document barriers to digital health adoption, including growing privacy concerns among patients and providers, limited digital literacy, shortages in human resources, inadequate technological infrastructure and internet coverage, and constraints linked to cultural norms, practices, and literacy levels.

In light of these realities, and prior to pursuing technologically advanced solutions, countries should align with the Regional Strategy for Digital Health in the Eastern Mediterranean Region (2023–2027). This entails assessing national digital health priorities; examining existing systems, standards, infrastructure, and policies; identifying gaps, resource needs, and priority areas; and evaluating emerging digital technologies and applications to determine their suitability for supporting health systems in line with country-specific needs.

Such analysis must be closely linked to health policy formulation and implementation, institutional capacity-building, and strengthened coordination and partnerships both within and across countries. This approach is essential to ensure the safe and effective use of artificial intelligence and digital technologies, improve service quality, and reduce inequities, consistent with the objectives of the regional digital health strategy.

Moreover, technological deployment should prioritize community health and preventive approaches rather than reinforcing a predominantly curative model. Evidence suggests that disproportionate spending on medical equipment and technology has entrenched treatment-centered systems, particularly in managing non-communicable diseases. This dynamic contributes to rising healthcare costs and overreliance on curative services, placing additional strain on already limited resources and diverting attention from comprehensive public health and prevention strategies.

Regional cooperation should be strengthened to leverage advanced digital health capacities - such as virtual hospitals and specialized centers in countries including Egypt, Pakistan, and Saudi Arabia - to support resource-limited settings in delivering remote and specialized care. These efforts should be institutionalized through sustainable inter-facility agreements and collaborative mechanisms aimed at bridging service gaps in underserved environments.

To ensure effective implementation, operational responsibility should rest with Ministries of Health, Ministries of Communications, and national digital transformation authorities, in coordination with regional bodies such as the Council of Arab Health Ministers and the WHO Regional Office. Clear governance and oversight mechanisms are essential to harmonize roles, coordinate action, and monitor progress.

Research consistently affirms that artificial intelligence holds transformative potential for public health systems in the Middle East and North Africa. However, its success depends on robust legal and regulatory environments, sustained investment in digital infrastructure, and the development of qualified human capital. Gulf experiences demonstrate the region's capacity to emerge as a global hub for health innovation when cooperation and knowledge exchange are expanded.

The adoption of AI in public health is not solely a matter of improving care delivery; it is also integral to advancing health equity and sustainable development. Strengthening AI-enabled health systems contributes directly to several Sustainable Development Goals - particularly the goal of ensuring healthy lives and promoting well-being - by enhancing service quality, narrowing health disparities, and advancing a more equitable and efficient health system for the region's future.

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Investment in Artificial Intelligence to Promote Public Health in the Middle East and North Africa: Current Status and Future Challenges

An Analytical Review

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