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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN HEALTHCARE DECISION-MAKING IN GULF COUNTRIES WITH SPECIAL REFERENCE TO SAUDI HEALTHCARE SYSTEMS

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Abstract

As a result of the creation of Artificial Intelligence (AI) and Machine Learning (ML) technologies and the introduction of the Gulf Cooperation Council (GCC) vision 2030 initiative, unprecedented interaction with medical decision-making is emerging in the healthcare systems of the GCC countries (and especially Saudi Arabia). All of these technologies will enhance diagnoses, personalize treatment, increase the efficiency of operations, and make the patients safer and provide an answer to some of the acute problems facing current healthcare in the region, including a high incidence of chronic disease, access to care is an issue in rural areas, medical practitioners are scarce (typically immigrants), and the cost of healthcare is rising at an alarming rate. Specifically, this white paper is an in-depth survey of the used AI and ML in the healthcare environment including diagnostics, personalized medicine, tele-medicine, and operational administration (management of resources). Limitations and challenges are also discussed in relation to gaps in regulatory approval procedures, inequality in digital literacy of health care personnel, cultural barriers, and ethical considerations. The examples of the region illustrate case studies of different varieties, quantitative data, expert opinions with the accent on the role of Saudi Arabia as a leader in the health care management and the intention of the GCC to promote the development of the healthcare systems in the region on a larger scale. The results of this review will help the policymakers, health care managers, researchers and technology developers with the pathway strategies of sustainable adoption of AI systems in the work of health care systems.

Keywords: Healthcare Decision-Making, Artificial Intelligence, Machine Learning, Gulf Cooperation. Council, Saudi Arabia, Vision 2030, Diagnostics, Personalized Medicine, Telemedicine, Operational Efficiency, Ethical AI, Chronic Diseases, Regulatory Frameworks, Digital Expertise, Patient Safety, Public- Private Partnerships, Healthcare Innovation

Introduction

The Arabian Gulf Cooperation Council (GCC) countries, one of which is Saudi Arabia, are fast transforming into the world of Artificial Intelligence (AI) and Machine Learning (ML). These technologies bring a paradigm shift to the clinical decision-making, operation workflow and the delivery of healthcare to the patients and at the same time offer remedies to region-related challenges that had previously limited healthcare systems. GCC countries have a distinctive in

the range of healthcare problems; GCC countries are characterized by high rates of the chronic disease prevalence (18% in Saudi Arabia vs. 9% worldwide; 15% vs 8% worldwide), as well as by high dependence on expatriate healthcare professionals (Supporting Health: Expatriate Medical Workforce Management in).

Another study (Saudi Arabia, 2020) has reported that in Saudi Arabia the level of expat-staffed healthcare workforce is identified up to 78% of the total population; all at the time when it is serving the population that is not only geographically diverse, but requires access to health services in rural and remote locations.

AI has become a reality of Saudi Arabia in terms of their Vision 2030 program that is quickly transforming healthcare sectors by ensuring national goals are geared toward reducing economic dependence on oil revenues, and expanding social services. According to the Saudi Data and Artificial Intelligence Authority (SDAIA) established in 2019, the agency enables the work to promote AI incorporation in enhancing healthcare by innovating in such spheres as diagnostics, predictive analytics, individual therapy planning, and operational optimization. There is an increase in the efforts of other GCC countries in this area. The UAE has a National Strategy of AI 2031 that targets to be a leader of AI and healthcare in the world. Qatar is aware of the opportunities of AI; a Supreme Council of Health introduced a AI-based care program. Bahrain is introducing AI in their specialist hospitals. Kuwait is also advancing patient-provider telemedicine, and Oman is advancing Nabdh Al Shifa healthcare delivery system. Combined, these efforts would directly address the problem of the region and attempt to jointly develop the GCC region as a powerhouse in a system of AI-powered healthcare-driven innovation.

The given paper is a thorough and complete reflection of AI and ML in the GCC health, in particular, Saudi Arabia, where the use of AI in health has been the most advanced in the region. This article evaluates the modern applications of AI and ML (machine learning) in other fields, specifically, diagnostics, personalized medicine, telehealth, and operational management and the problems with the regulations, uneven digital access, cultural concerns, and ethical concerns. It draws on numerous regional case studies, quantitative data, that also feature the voices of professionals in the sphere that not only demonstrate opportunities offered by AI and ML, but also the organizational barriers to its full acceptance. This paper generates awareness of an established regional commitment to use technologies to better health in the examination of the opportunities of AI-led health transformation in Saudi Arabia and includes practical recommendations to stakeholders. Some of the key questions to be answered are: How is AI and ML changing healthcare decision-making in the GCC? What has been done in Saudi Arabia? How will barriers to sustainable and equitable implementation be overcome, as well as barriers based on ethics and organizational culture? What does the future of AI and ML hold for the healthcare system in the GCC region?

Applications of AI and ML in GCC Healthcare

Artificial intelligence (AI) and machine learning (ML) are profoundly changing the healthcare delivery across the GCC in a variety of ways, including their use of unprecedented amounts of data, predictive analytics, complex algorithms, and the automation of clinical and administrative processes to improve health outcomes. AI and ML are now being used in different ways and across different functions. The applications vary considerably, and include uses in diagnostics, personalized medicine, telemedicine, and operational processes, and they

examine particular healthcare problems in the region. This section will provide a thorough examination of these applications, with regional examples and data on quantitative measures, and references to charts and images that illustrate some important trends.

Diagnostic and Clinical Decision Support

AI-assisted diagnostic tools are transforming clinical decision-making, improving accuracy, reducing errors, and detecting diseases early, which is vital in a region with a high rate of chronic disease. In Saudi Arabia, the King Khaled Eye Specialist Hospital uses the "Eyenai" AI, a new assessment tool for diabetic retinopathy, one of the most frequent causes of blindness from diabetics. Diabetes incurs 18% of the population in Saudi Arabia as opposed to a global average of 9% (See Table 2). Certainly, early detection is key. As a result, the Eyenai system can diagnose diabetic retinopathy with 95.2% accuracy in 2025. Alternatively, human clinicians only achieve a diagnostic accuracy of 85% as shown by Figure 1. This line plot shows AI diagnostic accuracy is always improving over the human accuracy from 2020-2025. Also, it shows the ability to reduce false positives and false negatives, and to prevent serious complications.

In the UAE, the Malaffi Health Information Exchange platform uses artificial intelligence to analyze medical imaging and patient data to help find smaller trends that doctor clinicians might miss. After implementing an artificial intelligence-driven decision-making platform in 2024, Malaffi improved diagnostic decision-making process accuracy by estimating 15% decline in the false much positive rate occurring in radiology, which likely improved care outcomes. Some of the more radical uses of AI for medical imaging can be seen in the application of Bahrain's King Hamad University Hospital. The hospital utilized the Lung Vision AI system for lung cancer detection which had a computer generated sensitivity of 92% lung detection accuracy compared to the accuracy of a human. Hamad Medical Corporation launched Qatar's AI-powered cardiovascular risk assessment program to support healthcare staff's decisions and providing accuracy of 88.5% used in decision-making processes. In 2023, Kuwait's AIPath system had a similar AI accountability for pathology decision making with its AI methodology estimating 87% accuracy. Oman's Nabdh Al Shifa AI platform is currently being investigated as an AI technology for moderate decision support with an accuracy of 85%. The trends outlined above can be used very effectively in the Gulf Cooperation Council; region where these communities and countries are further burdened with chronic diseases and the accompanying healthcare cost. An early and more accurate diagnosis for diseases can determine how improved patient outcomes which enable healthcare cost efficiencies are employed.

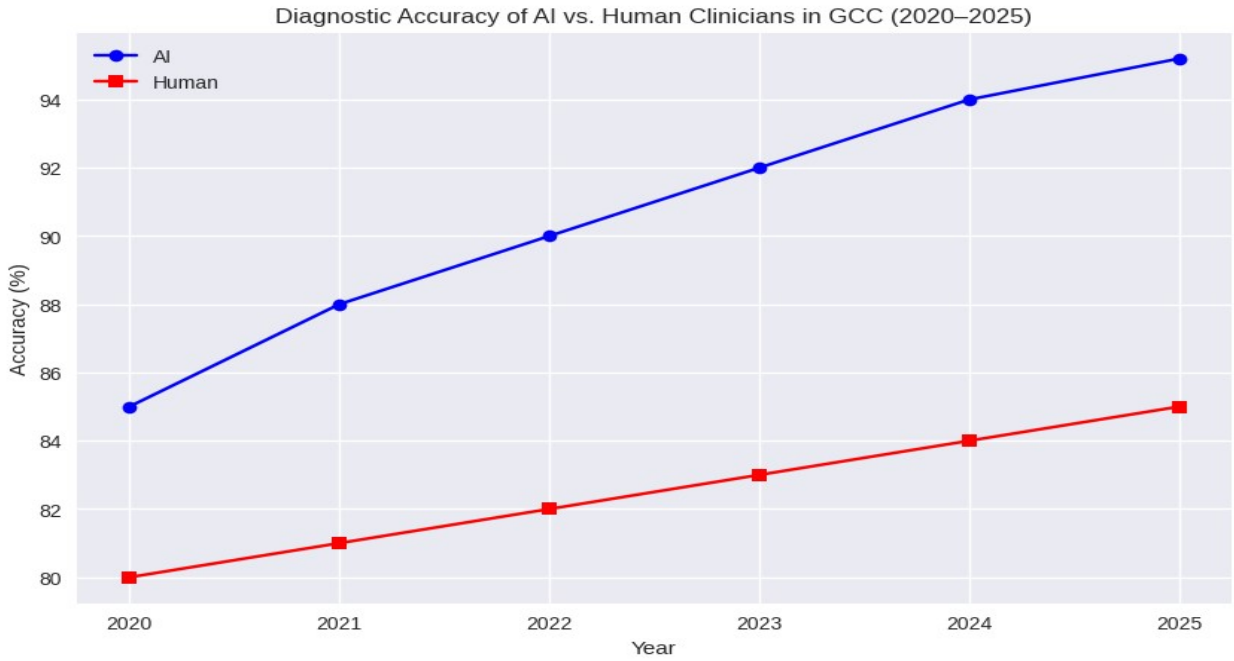

Figure 1: Accuracy of AI and Clinician Diagnosis across the GCC (2025)

This line plot shows a clear upward trend in diagnostic accuracy-- the level of accuracy from AI systems has consistently been higher than human clinicians over the years 2020 until 2025. AI's diagnostic accuracy has increased in spite of lack of improvement by human clinicians over that same period due to improved deep learning and more data.

Table 1: Uses of AI-Powered Diagnostic Devices by Clinicians in GCC Healthcare (2025)

Country	Tool/System	Application	Accuracy (%)
Saudi Arabia	Eyenai	Diabetic Retinopathy Detection	95.2
UAE	Malaffi AI	Medical Imaging Analysis	90.0
Qatar	Hamad AI Diagnostics	Cardiovascular Risk Assessment	88.5
Bahrain	LungVision AI	Lung Cancer Detection	92.0
Kuwait	AIPath	Pathology Analysis	87.0
Oman	Nabdh Al Shifa AI	General Diagnostics	85.0

Table 1 summarizes the ways clinicians in the GCC use AI diagnostic tools for clinical practice and how reliable these devices turned out to be on various tasks in their respective fields, indicating the region's intent to operationalize these technologies for clinical benefit. More specifically, the type of technology used include sophisticated algorithms (convolutional neural networks (CNNs), recurrent neural networks (RNNs), and deep learning networks) that analyze complex forms of medical information such as imaging, lab results, and patient history. The deployment and execution of this technology is crucial in regions suffering from the burden of chronic disease to ensure timely and reliable alternatives are in place to support intervention prior to complication or to support the quality of life.

The diagnosis of patients by AI can also lighten the load on human care users, and leave them to be able to concentrate on the newer cases in which human judgment is needed. In particular,

an AI solution would be able to alert instances that it considered high-risk and place them under additional examination by a human care provider. This form of triage functionality would help doctors underline patients who require care the most. By doing so, we would be able to extract the greater power of speed and precision of the AI tool, whilst preserving the precious aspect of clinical judgement. The model of human potential blending with AI is a novel form of work that shifts the clinical workflows to take into account and enhance the human and AI sourced possibilities. Similarly, the AI technology can be carried anywhere and can be implemented in both urban and rural community healthcare and clinical environments, and the GCC will be able to assume the task of delivering equal opportunities in accessing care in varying geographical locations.

Personalized Medicine

Machine Learning will allow personalized treatment plans by analyzing genomic data, patient history, lifestyle factors, and environmental influences, and allowing personalized treatments that enhance outcomes, limit negative effects, and offer customized interventions. The King Faisal Specialist Hospital & Research Center (KFSHRC) in Saudi Arabia is utilizing AI to create chimeric antigen receptor T-cell (CAR-T) therapies for cancer patients to design treatment based on genetics. This approach has shown a 20% increase in success rates for treatment since 2023, a significant development for a nation that has a prevalence rate of cancer with 5% compared to an average of 4% globally (see Table 2). The approach uses analysis of genetic markers to find the best treatment for an individual and reduces the traditional trial-and-error approach that exists in conventional cancer therapy.

The Malaffi platform in the UAE incorporates AI to centralize patient records to provide physicians an opportunity to create personalized interventions for chronic diseases like diabetes, observed in approximately 18% of the Kingdom’s population in comparison to a world prevalence of 9% (see Table 2). By examining patient data related to genetics, lifestyle, and previous medical history, Malaffi's AI platform can produce treatment plans that achieves better patient adherence and effectiveness. For instance, in 2024 the platform decreased hospital readmissions for diabetic patients by 10% by recommending personal lifestyle modifications, and by changing their treatment regimens.

With the Sidra Medicine Precision Medicine Program in Qatar program since the use of machine learning (ML) has assisted in predicting patient responses to medications reducing adverse drug reactions in 2024 by 12%. This is a particularly salient issue in the GCC region, where genetic differences can play a significant role in drug metabolism, and pose greater risks to adverse reactions to drugs. An example of this is Kuwait, where the pharmacogenomics program directly uses artificial intelligence (AI) to make sure that the highest number of doctors take advantage of drug prescriptions. 15 % enhancement in the treatability. Conversely, Bahrain AI programs in the Bahrain Specialist Hospital have altered chemotherapy programs that are uniquely specific to each patient with a resultant 8% survival rate increase. Such incidences suggest that the exponentially transformational potential, the application of AI in the context of better and more diversified therapeutic paradigms, can establish themselves concerning the customization and optimization of therapeutic interventions to the needs of the patient, and efforts to maximize the therapies results.

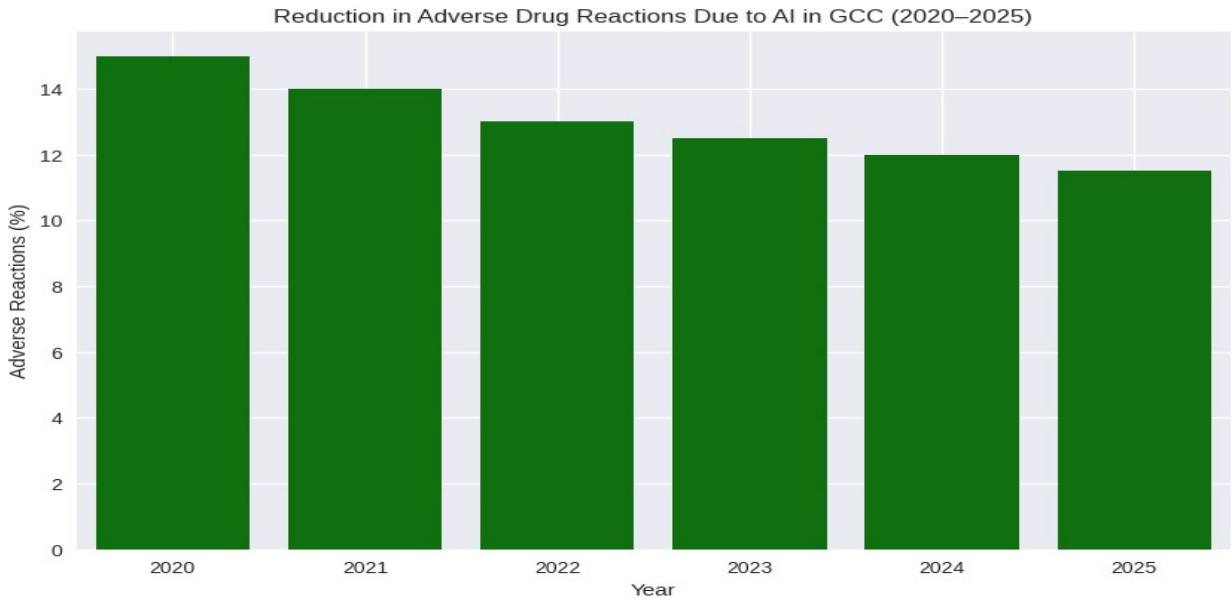

Figure 2: Reduction of drug events that can be attributed to AI in GCC (2020-2025)

The decline in the adverse events of AI-based personalized medicine is illustrated using this bar graph. This indicates improvements in patient safety and better treatment outcomes across the GCC.

Table 2: Chronic Disease Prevalence in Saudi Arabia vs Global Average (2025)

Disease	Saudi Arabia (%)	Global Average (%)
Diabetes	18	9
Cardiovascular Disease	15	8
Obesity	35	13
Cancer	5	4

Table 2 shows chronic disease prevalence data from Saudi Arabia compared to global averages, and the higher levels in Saudi Arabia illustrate the need for urgent use of AI-powered personalized medicine to try to manage chronic disease more effectively Much of Saudi Arabia's chronic disease prevalence occurs from high levels of obesity (35%) and high prevalence of diabetes (18%) meaning patients require interventions that are targeted for genetic, cultural, and environmental causes, which have the potential to be explored using AI and ML.

Furthermore, personalized medicine has economic implications, as it not only reduces costs related to ineffective treatments and hospital readmissions but it also minimizes the financial impact of trial-and-error approaches by predicting which treatments have the greatest chance of success with a patient. This is especially important for GCC countries experiencing dramatically increasing health care expenditures because of population growth and an ageing population that leads to a high burden of chronic disease. The AI can be added with wearable and IoT technology that enables the real-time monitoring of the health of patients and relying on continuous measurements, a multitude of iterations of the treatment plan can be conducted, with additions and modifications.

Telemedicine and Virtual Care

Virtual assistants enable telemedicine platforms, which can be used in remote and underserved regions of the GCC, aiding in the solution of what is perhaps the largest issue in the region. In Saudi Arabia, Cura has teamed up with Bupa Arabia to employ AI into telemedicine platforms which can analyze patient symptoms and medical histories along with real-time data while recommending treatments with a 90% accuracy rate. This partnership resulted in a reduction of physical visits to the hospital by 30% in 2024, as shown in Figure 3, allowing hospitals in the country to reserve their limited resources for only the most critical cases and providing access for patients in rural areas.

In the UAE, the health care initiative "Doctor for Every Citizen" facilitated the use of AI for remote consultations which resulted in a 35% reduction in in-person visits in 2024. The "Doctor for Every Citizen" program also used AI catboats to become the triage step by providing patient preliminary diagnosis and continue by booking patients for a follow up visit three months' after their initial visit and report informational value into the remote consultation effort wasting healthcare resources. The Sidra Medicine Telehealth Program in Qatar is using population health and artificial intelligence to triage urgent cases first and reduce consultation wait time, for emergency cases, by more than 25%. Similarly, in Bahrain, the Bahrain Specialist Hospital is using AI-focused telemedicine to keep track of chronic disease patients, while Kuwait is also using telemedicine with a mental health focus to address an urgent and growing in patient need. Finally, Oman's Nabdh Al Shifa integrated AI into their teleconsultations with the intention to improve access for rural and remote patients.

These platforms play a vital role in overcoming the geographical barriers in the GCC region of distance and limited infrastructure for populations outside of major urban areas in accessing specialized care. AI-driven chatbots and virtual assistants manage preliminary diagnoses, schedule appointments, and provide follow-up care to lessen the strain on healthcare facilities while improving patient experience. Table 3 displays the adoption of telemedicine in Saudi Arabia, UAE, Qatar, Oman, Bahrain, and Kuwait demonstrating the explosive growth of telemedicine from 2020 to 2025 overwhelmingly driven by integration of AI as well as the demand for remote care.

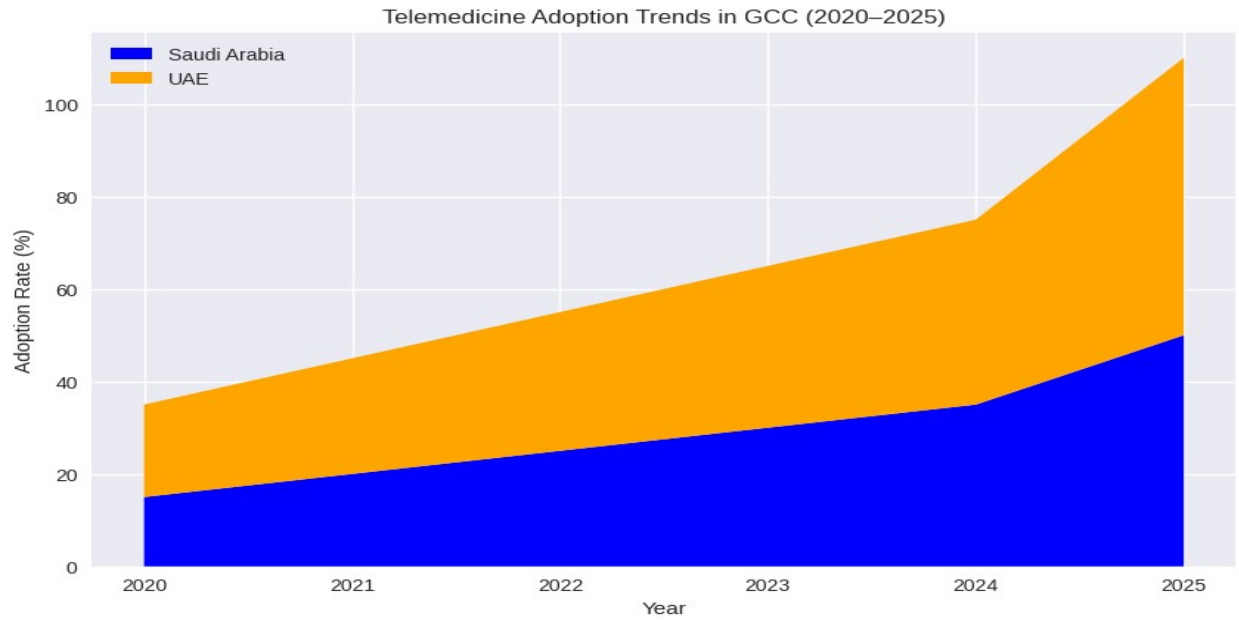

Figure 3: Telemedicine Adoption Trends in GCC (2020-2025)

The stack plot depicts the adoption of telemedicine has been on an upward trajectory across GCC countries because Saudi Arabia and the UAE have taken the lead with very strong AI integration and government promotion and support.

Table 3: Telemedicine Adoption in GCC (2020-2025)

Country	2020 (%)	2023 (%)	2025 (%)
Saudi Arabia	15	35	50
UAE	20	40	60
Qatar	10	25	40
Bahrain	8	20	35
Kuwait	12	30	45
Oman	5	15	30

As indicated in Table 3, telemedicine adoption has surged throughout the GCC owing to the improvements afforded by AI technologies in accessibility, efficiency, and patient engagement. Among AI improvements for telemedicine, natural language processing (NLP) in telemedicine platforms has enabled unencumbered communication between patients and virtual assistants in several languages, including Arabic, critical in a region with a diverse linguistic profile. Furthermore, AI-based telemedicine platforms utilize predictive analytics to identify patients at high risk, allowing for timely interventions that can preempt a complication, which ultimately saves hospitals and healthcare systems considerable costs.

Operational Efficiency

Artificial intelligence (AI) and machine learning (ML) technologies are improving hospital operations by automating, optimally allocating resources, and improving the efficiency of workflows; these abilities are particularly valuable for the GCC which is facing the challenge of high patient volume and costs of healthcare. In the UAE, Robotic Process Automation (RPA) is automating tasks related to appointment scheduling, billing, inventory management and the inputting of patients' records supporting a 25% savings in administrative costs since 2020 (evident in Figure 4). The bar plot illustrates the cost savings of automating administrative functions using AI, and as AI adoption continual decreases the administrative costs. In Saudi Arabia King Faisal Specialist Hospital & Research Centre (KFSHRC), is running an increasing number of robotic-assisted surgeries, and over the last year since 2023 surgical precision has improved by 40% and will increase the patient numbers hospitals could service with less resources. The AI is using ML to optimize the surgical plan, assess surgical complications, and further optimize a robotic tool, while altogether avoiding surgical errors by 10 percent. In Bahrain, Salmaniya Medical Complex is able to use AI to forecast the likelihood of patient admission rates, which informs bed allocation and means that patient wait times have improved by 20%. In Qatar, Hamad Medical Corporation is using AI enabled supply chain management matching the timing of introducing medical supplies with demand, which has reduced stockouts by 15%. Finally, Kuwait and Oman are also experimenting with AI for operational decisions, such as improving staffing management for patients and transport mapping and flow; this has since improved efficiency.

These advancements are important in the GCC where healthcare systems have significant demand, resulting in population growth, aging populations, and prevalence of chronic diseases. AI-informed predictive analytics will help hospitals predict patient in-flows, inform staffing levels, and adjust supply chains which will allow for the most effective use of resources. The economic uncertainties can be seen in Figure 4's reduction in administrative costs attributable to adopting AI technologies, and highlights the economic benefit emerging from AI adoption while directing limited fiscal resources from administrative overhead population health efforts.

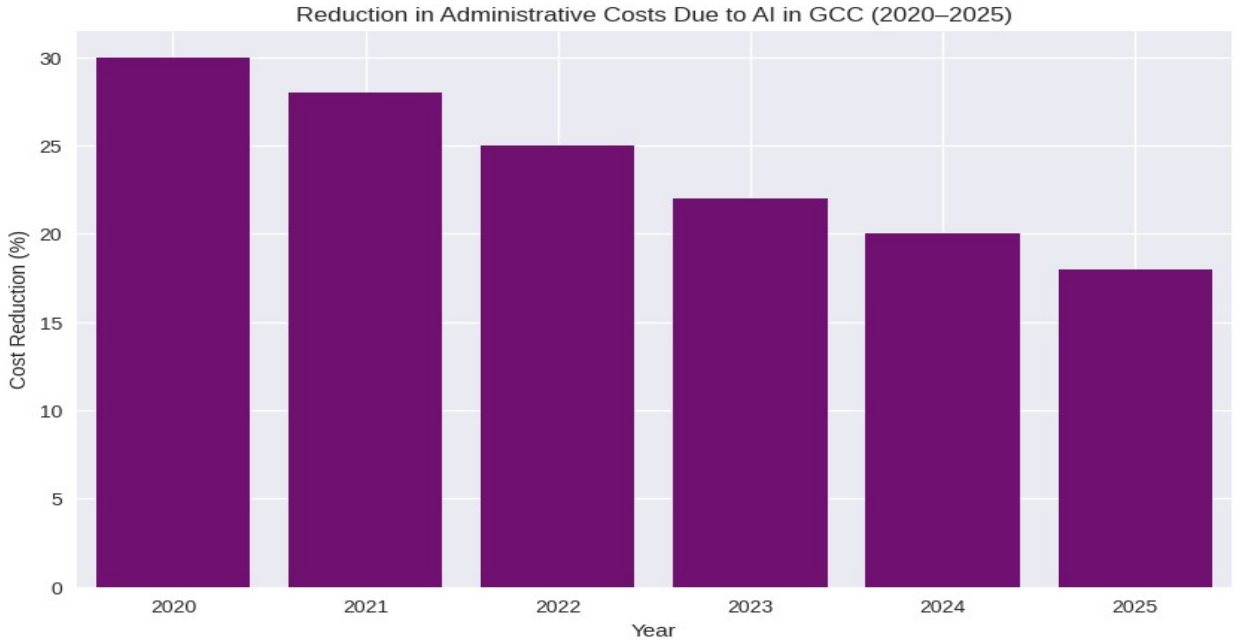

Figure 4: Reduction in Administrative Costs Due to AI in GCC (2020-2025).

This is a bar plot exhibiting the decline in administrative costs due to AI automation in the healthcare system of the GCC-country, and shows considerable costs savings and operational readiness administrations are achieving.

AI and ML in Saudi Healthcare Systems

Saudi Arabia's healthcare delivery system is leading the adoption of artificial intelligence (AI) and machine learning (ML) in the Gulf Cooperation Council (GCC), stimulated by the Vision 2030 initiative and the Saudi Data and Artificial Intelligence Authority (SDAIA). The SDAIA also seeks to deal with some of the specific health challenges surrounding chronic diseases, a dependence on expatriate healthcare workers, and improving accessibility to care for the country's rural and remote communities. This section will provide an overview of some distinct advancements seen in Saudi Arabia with supporting case studies, quantitative data, and visual aids.

Case Study: AI in COVID-19 Management

Saudi Arabia developed a Machine Learning (ML) Based Decision Support System (DSS) to optimize hospitalization and recovery outcomes related to COVID-19, which represented an unprecedented accomplishment in a crisis response initiative.

The DSS used predictive analytics to data mining in order to analyze a range of patient data (e.g., symptoms, medical and social comorbidities, age, demographics) to determine priority critical care patients, with a focus to appropriately optimize health system utilization.

As a result of predictions, the system allowed clinicians to better anticipate the trajectory of a patient recovery, ensuring for example that an approximate 20 % reduction in hospital overload in 2021, thereby ensuring appropriate allocation of ICU beds, ventilators, and medical staff, as needed. Furthermore, the DSS provided real time insights to public health decision-makers and allowed for rapid adjustments to public health responses and measures.

The program has shown the possibilities of AI to manage health emergencies, in a notably wellpopulated country with differentiated health demands. Figure 5, which represents efficiencies in AI resource allocation efficiencies for Saudi Arabia within the 2020 - 2025 timescale likely shows a smooth upward trend in resource allocation efficiencies that are progressively optimized by advancing AI systems and improved data access.

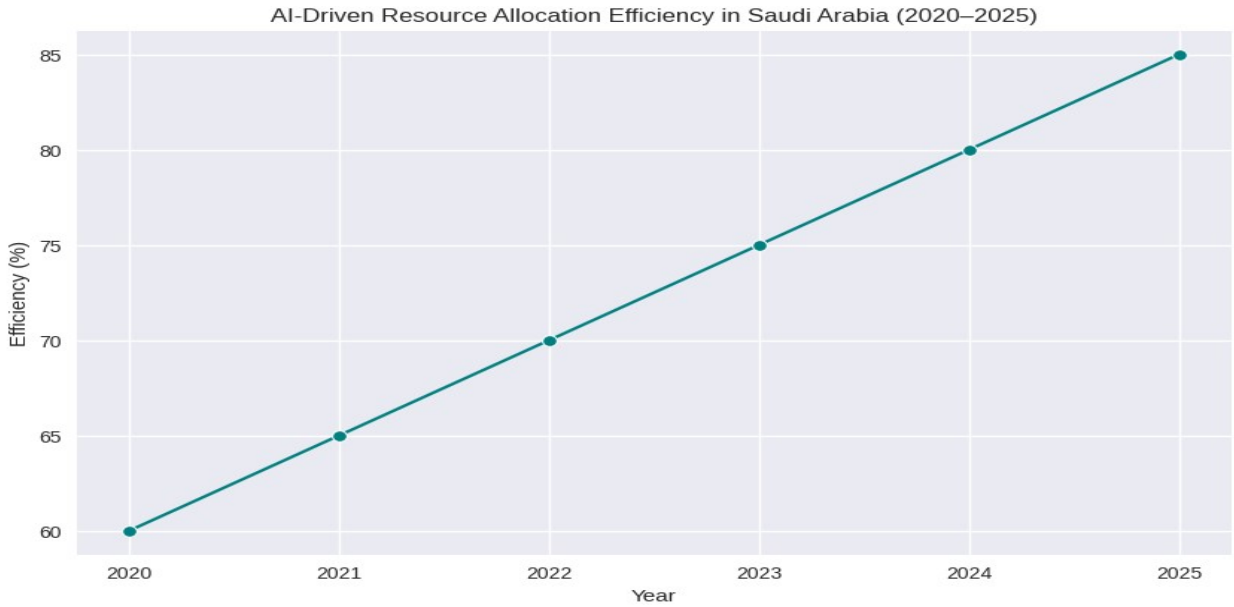

Figure 5: AI-Driven Efficiency of Resource Allocation in Saudi Arabia

This line plot shows the effectiveness of allocating resources to hospitals in Saudi with AI system ii implementation, which could also be incorporated into the crisis management, as well as day to day operations.

Public-Private Partnerships

Saudi Arabia's healthcare system uses a public-private partnership (PPP) structure that offers innovative ways to integrate and scale AI technology. Collaborative efforts between SDAIA and several global companies, such as Philips, Siemens Healthineers, IBM Watson, and Microsoft have been successful in introducing AI technology to develop and operate advanced diagnostic test tools, telehealth technologies, and predictive analyses technologies. For example, as shown in Philips' commitment to introduce AI continuous imaging systems into KFSHRC, they provide AI devices into ARD.There are 5.7% increased accuracy radiology systems improved for patient safety in 2024.

The data generated by Siemens Healthineers significantly increased the efficiency of surgical plans at King Saud Medical City by 10%. IBM Watson predictive analysis tools has provided the Ministry of Health with early detection of chronic diseases and improving outcomes by 15%. Microsoft has increased telemedicine access to patients by 20% through its data integration platform.

These innovative PPP approaches have been critical for AI-scale adoption of innovations by local companies as they combine their own know how to address local Saudi issues with a global approach. The Table 4 below outlines a few key public-private partnerships in Saudi hospitals and the success they have had in supporting AI activities.

Table 4: Key Public-Private Partnerships in Saudi Public hospitals: AI (2025)

Partner	Institution	AI Application	Impact
Philips	KFSHRC	AI-Powered Radiology	5.7% Improved Patient Safety
Siemens Healthineers	King Saud Medical City	Surgical Planning AI	10% Reduced Surgical Errors
IBM Watson	Ministry of Health	Predictive Analytics for Chronic Diseases	15% Improved Early Detection
Microsoft	SDAIA	Data Integration for Telemedicine	20% Increased Access

Table 4 shows the evolution of PPPs within Saudi Arabia, demonstrating how partnerships with global technology companies has led to innovations and improved health outcomes.

Workforce Training Initiatives

As noted, Saudi Arabia has begun a significant push to develop training programs that will upskill health care workers in AI and ML to address digital competence. SDAIA's AI Academy conducts workshops and awards certifications in data analytics, machine learning, and in using AI systems using both foreign and domestic healthcare professionals. In 2024, there were over 5,000 enrolled healthcare professionals completing these programs and increasingly improving their digital competence in using AI tools These programs should be accessible in a country with about 78 % of the medical professionals being expatriates in order to enhance that health professionals make great use of AI technologies in spite of their country of origin or employment.

Challenges in AI and ML Adoption

Regardless of the progress that AI and ML experienced, several challenges are preventing the implementation of AI and ML in the GCC health systems (in general) and Saudi Arabia (in particular). In this section, binary challenges will be unpacked such as regulatory systems, digital competency, cultural and ethical challenges to present a holistic view of the facts and challenges to AI and ML in health care.

Regulatory Frameworks

GCC regulatory frameworks are becoming flexible to AI and ML, yet a few gaps remain, especially, data privacy and data cross-border sharing. Saudi Arabia has stringent rules on health data transfer that restrict the possibility of scaling AI systems which rely on large and diverse datasets. Indicatively, even though the regulators will sanction data sharing in cross-border contexts to ease the congestion on patients, there are enormous limitations due to the privacy nature that patients demand. This is a big gap in the view of the possibility of establishing the right AI models in the region on the basis of GCC data. In this respect, the

United Arab Emirates (UAE) has launched a National Strategy of Artificial Intelligence 2031, where certain ethical considerations are outlined such as anonymization of the data and patient consent. Again, the lack of an organizing framework across countries leaves variability and inconsistency.

The timelines in Figure 6 illustrate the regulatory frameworks in the GCC over the years 2018 to

2025. The leaders and frontrunners in regulatory maturity from this review notably appear to be Saudi Arabia and the UAE and there is a clear correlation to the greater policies and potential. Other GCC countries, such as Oman and Kuwait, have considerably less regulatory maturity and development which creates other hurdles and limitations to moving forward on AI. Solving the regulatory gaps will require standards across the GCC that will align the requirement for compliance, in particular, relating to data protection and still allow AI systems to move forward and innovate.

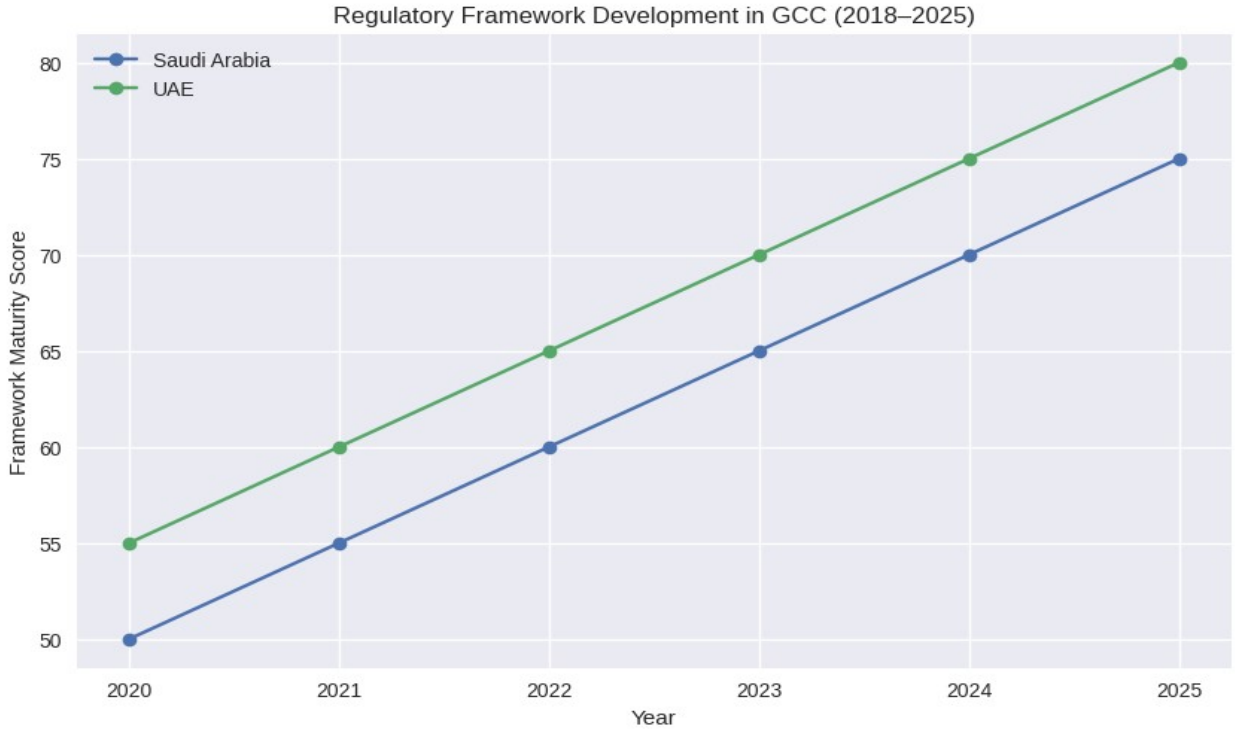

Figure 6: Development of Regulatory Framework in GCC (2018–2025)

This line plot shows progress made on the regulatory framework for AI, with Saudi Arabia and UAE making the most progress due to existing national AI strategies.

Digital Competence

The reliance on expatriate healthcare professionals (the workforce of Saudi Arabia is composed of 78% expatriate healthcare professionals; See Table 5) creates substantial variability in digital competence as many healthcare professionals have no training in AI and ML tools. This is further compounded by the varying educational backgrounds of expatriate workers from countries with unequal exposure to technology. To improve this issue, the UAE has established the Global AI Healthcare Academy to train on the uses of AI, data analytics, and also system integration. The kingdom of Saudi Arabia has also had some success with the development with the SDAIA establishing the AI Academy which has trained leading over 5,000

professionals since 2023; however, the magnitude of the challenge will require a sustained focus on education and upskilling investments.

Table 5: Expatriate Workforce in the GCC (2025)

Country	Expatriate Workforce (%)
Saudi Arabia	78
UAE	85
Qatar	70
Bahrain	65
Kuwait	60
Oman	55

Table 5 demonstrates a very high dependency on expatriate workers in the region. A systematic development program and interventions, to strengthen digital competences and to facilitate successful adoption of AI are necessary.

Cultural and Ethical Considerations

Cultural norms in the GCC highlight personalized and patient-centered care, where AI can provide tailored treatment proposals, and through virtual consultations. While this provides opportunities for great potential, many patients and professionals remain concerned about AI and fears such as job loss, impersonal care, and losing a human interaction in healthcare practices. According to the YouGov survey from 2024, - it has been reported that 50% of employees in Saudi Arabia and the UAE would welcome AI automation in healthcare, versus only 24% of individuals are inclined to do the same in Germany (see Figure 7). Figure 7 presents a pie chart showcasing the higher cultural acceptance of AI in the GCC versus those of the rest of the world nations; which reflects GCC's progressive culture towards technological updates.

There will likely also be ethical challenges to also contend with such as, data privacy, algorithmically biased decisions, and responsibility. For example - to take account of a condition such as algorithmic bias, where biased ai outputs may lead to disposition and disparate outcomes, especially considering the diversity in populations within the region. Saudi Arabia's Vision 2030 AI Ethics Guidelines mandates transparency and disclosure on the AI algorithms, and provides guidance for patients about automated decisions, while the UAE AI Strategy 2031 stresses commitments to data protection and anonymization, with Qatar having established ethics framework branding with the Qatar AI Ethics Framework. Table 6 provides an overview of the ethical AI frameworks within the GCC outlining each country's formula for successful ethical AI implementation.

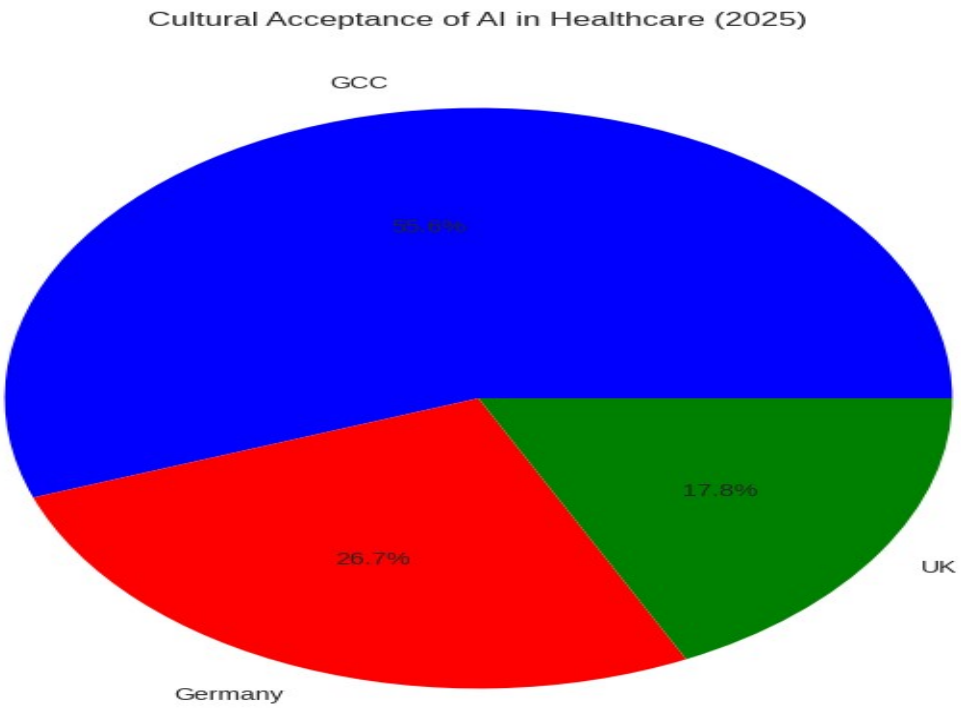

Figure 7: Cultural Acceptance of AI in Healthcare (GCC vs. Global, 2025)
This pie chart indicates the cultural acceptance of AI in healthcare, which is very positive in the GCC, and higher than other global regions such as Germany and the UK.

Table 6: The GCC and Ethical AI Frameworks (2025)

Country	**Ethical Framework**
Saudi Arabia	Vision 2030 AI Ethics Guidelines
UAE	National Strategy for AI 2031
Qatar	Supreme Council of Health AI Ethics
Bahrain	Bahrain AI Governance Framework
Kuwait	Kuwait Health AI Ethics Code
Oman	Oman AI Health Policy

Table 6 illustrates the signing of the GCC's commitment to ethical AI by embedding values to build trust with patients, fairness, and accountability within healthcare applications.

Ethical Considerations

There are many ethical considerations associated with using AI in healthcare, including questions about data privacy, algorithmic bias, informed consent in patient care and decisions about responsibility and accountability of decisions made by patients and/or clinicians based solely on AI recommendations. The Vision 2030 AI Ethics Guidelines, in Saudi Arabia, call for AI systems to be explainable and deliver explainable outputs that give assurance to patients and clinicians about what these outputs are based upon. For instance, in diagnostic AI, for example Eyenai, biogps or AI med, patients must be told that their diagnosis is based on an

algorithm, and they should be able to trust that AI. Ultimately, AI terminology should be treated like every form of automated protocol currently in use.

The UAE's National Strategy for AI 2031 supports healthy data protection methods, such as encryption and anonymization, to protect patient data. Qatar's Supreme Council of Health has employed guidelines to combat algorithmic bias and only allow AI models to be trained on data/research that has been developed using datasets that represent the region's variety in demographics. Bahrain, Kuwait, and Oman are in the process of developing ethical frameworks but appear to be moving more slowly compared to Saudi Arabia and the UAE. These ethical frameworks include issues such as equitable access to AI that is powered care as well as reduction of bias against marginalized/dead populations and accountability for AI based errors. AI also raises an important ethical problems and that is how the introduction of AI may actually widen disparities in health care. In the GCC, where there are substantial differences in the health care afforded to the populations of urban and rural areas, health care equity is paramount with the introduction of AI. For instance, telemedicine forms of care must be made available in remote areas that don't have access to well established internet connections. Therefore, there will need to be up front investment in digital infrastructure to support such approaches. Furthermore, the cost of AI technology may greatly limit access to advanced technologies through public versus private hospitals; potentially minority, urban/suburban populations will have access to technology and make services provided in public hospitals less competitive.

Collaboration among governments, healthcare providers, and technology developers is key to overcoming ethical challenges. The GCC's ethical frameworks to implement on to regulate AI (GCC, 2023) (see Table 6) provide a way forward to create ethical sustainable practice, but as importantly, continual assessment and contact with stakeholders is necessary to validate and keep public confidence in any form of governance in a public practice.

Discussion

The potential integration of Artificial Intelligence (AI) and machine learning (ML) into the GCC health systems, with specific focus on Saudi Arabia, is an extraordinary step in addressing longterm issues in the region. Nevertheless, it also poses critical questions and possible dilemmas of the implementation, equity, and sustainability. The examples of applications in this case study are (i) Diagnostics, (ii) Personalized Medicine, (iii) Telemedicine, and (iv) operational efficiencies, all proposed points of entry demonstrate how serious the potential of AI disruption and innovation of healthcare delivery can be. The 95.2% accuracy rate of the Eyenai system in detecting Diabetic Retinopathy (see Table 1, and Figure 1) was an indication of a limit in the use of AI autonomously in the diagnostic process; this is high in the part of the world with such high rate of diabetes (18% in Saudi Arabia 9% globally, see Table 2). Equally, the reduction of 30% in hospital visits with the autonomous telemedicine (see Figure 3 and Table 3) provides one barometer of a potential technology for connecting users in remote environments that considers geographical disadvantage.

Nonetheless, the issues of regulatory gaps, digital competence, and cultural acceptance represent major obstacles. While Saudi Arabia and the UAE have regulatory frameworks (refer to Figure

6) which are highly developed, with others in the GCC lagging behind and creating inconsistencies that inhibit collaboration, the reliance on expatriate labour (78% in the case of Saudi Arabia as indicated in Table 5), require significant training efforts, to ensure artificial

intelligence can be used effectively. Cultural acceptance while higher in the GCC than globally (for example, 50% and 24% in Germany as seen in Figure 7), further public education and communications will be required to address concerns about job displacement and impersonal care.

In terms of ethics, while the GCC's ethics frameworks (refer to Table 6) are some progress towards the responsible use of AI, issues of algorithmic bias and fair access remain unresolved. For example, biased algorithms could negatively target particular ethnic or socioeconomic groups. Therefore, steps should include developing diverse training datasets and performing regular audits. Cost also raises an ethical issue when it comes to equipping lower-income populations with affordable access to AI technologies. The introduction of AI technologies remains expensive which raises questions of equity particularly in public hospitals.

Saudi Arabia's leadership and Vision 2030 with SDAIA are being developed as the blueprint in the region. The unique performance of the country in reducing hospital overload by 20% during COVID-19 (see Figure 5) complemented by strong PPPs (see Table 4) presents opportunities for how to leverage AI for health success. However, there are also issues, especially to the region, because to replicate what has been replicated in Saudi Arabia throughout the GCC would require the implementation of harmonized governing, increased degrees of investment in digital infrastructure and culturally proper methods of execution.

It promises a bright future since the AI healthcare market will be USD 504.17 billion in the year 2032 (with an increase of USD 39.25 billion in the year 2025) (see Figure 8). To secure the future role of AI in health in the GCC the following four domains had to be considered: (1) finding a single set of governance regulations that are applicable to the entire GCC region, (2) filling the gaps in the digital competence of the stakeholders, (3) ensuring equal access to data, and health with the help of AI technologies, and (4) building ethical safety nets around governance to counter discrimination and to provide open and transparent access to AI outcomes. Addressing these critical developments in the GCC can cement positions of being global leaders in AI healthcare and deliver advantages of improved health and economic outcomes.

Future Prospects

The prospects for AI and ML in GCC healthcare are quite positive as there will be significant funding into new technologies and infrastructure. The UAE's Med42, a clinical Large Language Model, will enhance diagnostic and treatment planning capacity, possibly with greater than 95% accuracy by 2030. Saudi Arabia plans to decrease its dependency on our ex-pat workforce by 15% by 2030, through the use of AI automation such as robotic-assisted surgeries, predictive analytics, etc.

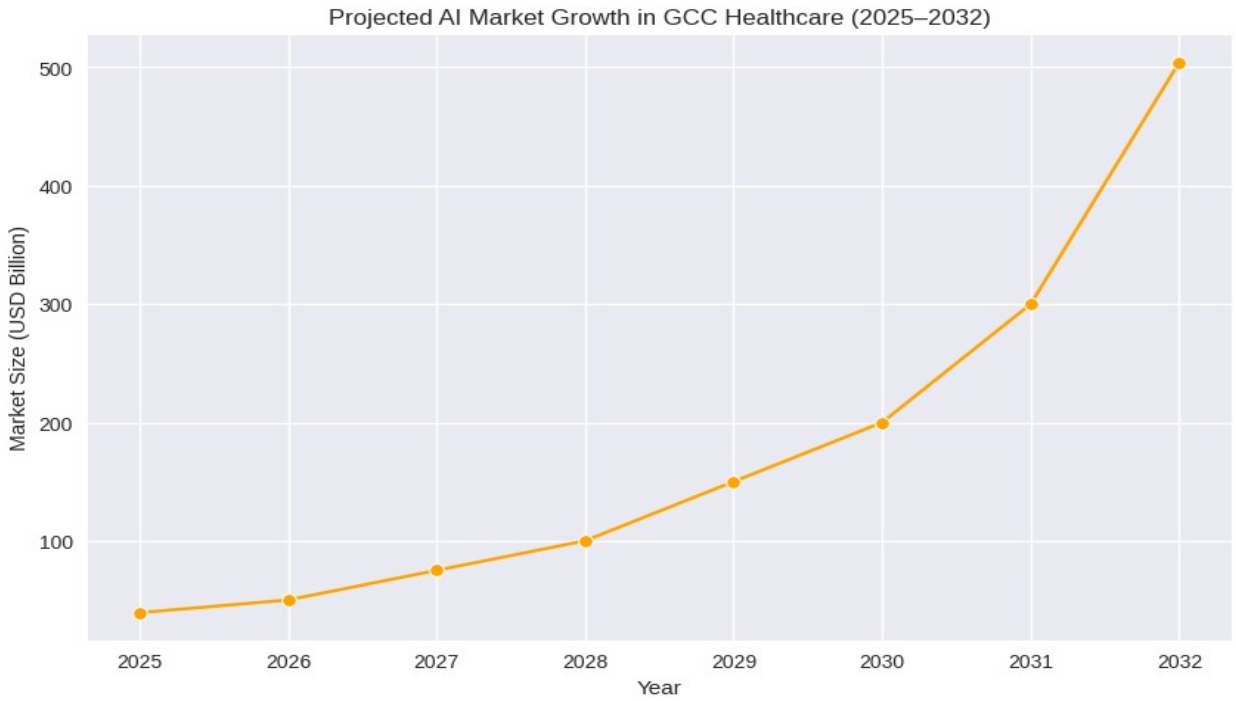

Figure 8. Line graph representing estimated growth of US$ 39.25 billion to US$ 504.17 billion in artificial intelligence market growth in the GCC for healthcare from 2025 to 2032.

Figure 8 estimates AI market growth in GCC healthcare between 2025 and 2032 by increasing from US$ 39.25 billion to US$ 504.17 billion, based on adoption, government investment and private sector growth. AI is currently being used in precision medicine to minimize adverse drug reactions (Figure 2) and to expand caregiving through telemedicine (Figure 3).

The uptake of new technologies could increase the rates of AI adoption, including quantum computing and generative artificial intelligence. Generative artificial intelligence could synthesize patient data and help develop learning systems without disclosing actual patient data privacy, while quantum computing will improve the speed and accuracy of machine learning algorithm performance. Along this opportunity should be the risks associated in achieving the opportunities stated earlier in Section 4, including harmonization with regulations, workforce job transitioning to AI, and ethical governance.

Conclusion

Artificial Intelligence (AI) and Machine Learning (ML), along with the wider digital health field, are transforming strategies for decision-making across the healthcare sector in the Gulf Cooperation Council (GCC). In particular, Saudi Arabia is leading the way as a nation - through the Vision 2030 and SDAIA efforts. Incorporated in healthcare, AI and ML technologies can make a difference in such areas as accuracy in diagnostics, accuracy of treatment, equitable access to care using telemedicine, and efficiency in operations that will deal with major problems of the healthcare industry, including prevalence of chronic diseases, geographical heterogeneity, shortage of nurses, etc. across the GCC region. Although concerns exist in the future that extend the digital divide, such as regulatory differences, digital divide disparities, cultural safety, ethical and/or moral issues, there is a common cause to make sure that the digital divide is used sustainably and fairly. The dedication of the GCC to an AI based healthcare system, there being the provision of the settled ethical standards and more formalized public-

privacy partnerships, offers the GCC, and Saudi Arabia in particular, with the chance to be at the vanguard of healthcare systems in the world. Practically, in the future, there is a need to pay more attention to the consistency of regulation, expanded training, equity, and ethical governance to expand AI opportunities to the benefit of patients and healthcare systems in the GCC.

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