

Advancing Genomic Medicine in the Middle East: Opportunities, Challenges, and the Path Forward

A whitepaper by  investopia

TABLE OF CONTENTS

- 3** INTRODUCTION
 - 4** CURRENT LANDSCAPE OF GENOMIC MEDICINE IN THE MIDDLE EAST
 - 5** CHALLENGES AND OPPORTUNITIES IN GENOMIC MEDICINE
 - 6** INFRASTRUCTURE AND TECHNOLOGICAL NEEDS
 - 7** FUTURE OUTLOOK AND RECOMMENDATIONS
 - 8** CONCLUSION
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INTRODUCTION

Genomic medicine, which leverages the power of genetics to tailor medical treatment to individual patients, is revolutionizing healthcare worldwide. The swift advancement of genomics technology has ushered in transformative changes in healthcare, akin to the revolutionary impacts of vaccines, antibiotics, anesthesia, germ theory, and advanced imaging. Future generations will experience a paradigm shift in healthcare, with personalized treatment becoming the norm and individuals gaining the tools to manage their health through valuable insights.

To highlight the pace of this evolution: nearly two decades ago, sequencing the first human genome took over 10 years and cost more than \$2 billion. Today, the same process can be completed in about 10 hours for roughly \$200, marking an unprecedented leap in technological progress.

These advancements mark a significant step forward in the development of precision medicine, but broader access to diverse genomic data is still essential. Scientists are working towards mapping the full spectrum of human genomes across the globe. With a population of over 400 million, the Middle East is one of the world's oldest inhabited regions, yet it remains highly underrepresented in genome sequencing. Currently, over 95% of available genomic data is derived from Western Europe and North America.

In the Middle East, this transformative field presents unique opportunities and challenges. With a rapidly evolving healthcare landscape and increasing investments in scientific research and innovation, the region is poised to become a key player in the global genomic medicine landscape.

However, significant barriers remain in terms of infrastructure, policy development, and access to cutting-edge technologies. At the same time, the region's rich genetic diversity offers a distinct advantage in advancing personalized medicine. By harnessing this diversity, Middle Eastern countries can not only improve healthcare outcomes within their populations but also contribute to global genomic research.



CURRENT LANDSCAPE OF GENOMIC MEDICINE IN THE MIDDLE EAST

Countries in the Middle East are leading the integration of genomics into their national healthcare frameworks. Saudi Arabia's recently launched National Biotechnology Strategy, aligned with Vision 2030, seeks to establish the nation as a global leader in biotechnology. The strategy focuses on expanding the national genomic database, creating a supportive regulatory framework, and utilizing precision medicine to enhance health outcomes. Similarly, Qatar and the UAE have implemented genome-mapping programs, with the UAE aiming to sequence the genomes of 1 million citizens to advance personalized cancer treatments.

Saudi Arabia has showcased a strong commitment to advancing its research and development agenda. Its National Aspirations and Priorities for Research, Development, and Innovation (RDI) over the next two decades emphasize "Health and Wellness" and "Economies of the Future." Supporting this vision, the Kingdom has launched several key initiatives, including the establishment of the National Biotechnology Strategy Committee and Riyadh Biotechnology City. Additionally, the Saudi Genome Project 2.0 aims to position the country as a regional leader in genomics and genetics within the MENA region. The country's genome programs have so far sequenced over 60,000 samples

The Qatar Genome Program (QGP) is a national initiative designed to sequence the genomes of the local population to advance genomic medicine in Qatar and the wider region. In its first phase, the program successfully sequenced the complete genomes of 6,045 individuals, using samples collected and preserved by the Qatar Biobank (QBB). Overall, the QGP has sequenced 35,000 full genomes.

Bahrain has significantly expanded its investment in genomic medicine, boosting its gene sequencing capacity to 20,000 whole genomes annually—2.5 times its previous capacity.

The Case of the UAE

In recent years, the UAE government has made substantial investments in infrastructure and research for genomic medicine, spearheading several new initiatives. These include the Emirati Genome Program (EGP), which was launched in 2019. The EGP seeks to transform healthcare by advancing the understanding of rare genetic disorders and developing personalized diagnostic tests and treatments. This public-private partnership, between healthcare technology firm G42 and Abu Dhabi's Department of Health, leverages genomic data from Emirati citizens to construct a comprehensive genetic map and establish an Emirati "reference genome." The initiative aspires to build one of the world's largest and most diverse genomic databases, with over 500,000 samples collected so far, and aims to involve every Emirati citizen in the project.

Launched in 2023, the National Genome Strategy (NGS) is a 10-year initiative designed to establish a legal framework for integrating genomics into healthcare and advancing personalized medicine in the UAE. The strategy tackles challenges associated with the large-scale adoption of genomic technologies, such as data protection and storage, by creating legislation to support secure data infrastructure. It also develops policies to align genomic applications with public health priorities, ensuring a cohesive and ethical approach to the use of genomics.

The UAE's progress in advancing precision medicine is further bolstered by collaborations with leading global institutions and the establishment of state-of-the-art research centers. A notable example is the partnership between Harvard Medical School and the UAE Genetic Diseases Association, where Harvard researchers are conducting whole genome sequencing to study the genetics of familial hypercholesterolemia and monogenic cardiac diseases in UAE patients. Recent investments from the pharmaceutical industry also highlight the region's growing prominence in the field. These include the opening of Virax Biolabs' regional headquarters, AstraZeneca's office in Dubai Science Park, and the launch of the Illumina Solutions Centre in Dubai in 2022. The Solutions Centre aims to equip researchers and clinicians with training on using genetic sequencing technologies across various medical and research applications.

CHALLENGES AND OPPORTUNITIES IN GENOMIC MEDICINE

Genomics technologies offer more than just advancements in healthcare—they represent a substantial economic opportunity for the Middle East. The genomics market in the Middle East and Africa is forecasted to reach \$1.2 billion by 2027, with a robust compound annual growth rate (CAGR) of approximately 10% between 2023 and 2027. This growth highlights the region's potential to position itself as a leader in the genomics sector, driving both economic development and innovation.

The UAE's development of genomic medicine is supported by robust infrastructure and streamlined processes, such as an expedited 28-day approval process for clinical trials. This efficiency has contributed to a 48% increase in trials conducted in Abu Dhabi in 2022 compared to the previous year. By significantly reducing the approval timeline—compared to the typical 12 months required by U.S. or EU regulators—the UAE has positioned itself as an attractive hub for entrepreneurs and researchers aiming to bring genomic innovations to market swiftly. Essential infrastructure, including biobanks, cold storage facilities, research universities, and life sciences parks in Dubai and Abu Dhabi, further underpins the nation's ability to support growing clinical trial activity and foster partnerships and investments in genomic medicine.

Opportunities for genomic medicine in the UAE are highlighted by initiatives like the Robotic BioBank in Dubai's Healthcare City, which is set to store 7 million human samples. This facility will serve as a vital resource for regional genetic research, reducing the need for local research groups to rely on international biobank partnerships. Additionally, the slightly higher prevalence of rare diseases in the UAE—affecting 7% of the population compared to the global average of 2-6%—presents a unique opportunity for advancement. For instance, a partnership between Abu Dhabi Health Services Company and Sanofi focuses on improving rare disease diagnostics, starting with lysosomal storage disorders.

The UAE's high-quality healthcare services ensure that advancements in precision medicine, particularly for rare diseases, can be made accessible to the population more quickly than in many other countries. Furthermore, Dubai and Abu Dhabi's developed transportation and tourism infrastructure position the UAE as a prime destination for medical tourism, further enhancing the appeal of its genomic medicine advancements.

Although Saudi Arabia contributes 1.3% of global GDP, it currently represents just 0.2% of the global genomics sector. This indicates that the genomics industry in the Kingdom is still in its early stages of development. Supporting this, the expected growth rate for the genomics sector in the MENA region from 2022 to 2030 is around 9.5% CAGR, significantly lower than the global growth rate of approximately 16.5%. This disparity underscores the potential for the region to increase its focus and investment in the genomics sector to unlock its growth opportunities.

The implementation of genomic medicine in the Middle East faces several challenges, including navigating the ethical implications of genomic research. Issues such as informed consent and the risk of genetic discrimination must be carefully managed to ensure public trust and the success of genomics-based healthcare initiatives. The UAE's introduction of the Genomics Law in 2023 highlights the recognition of these risks and the country's proactive approach to safeguarding ethical standards and protecting individual rights while advancing healthcare innovation.

Another critical challenge lies in managing and interpreting the vast volumes of complex genomic data generated by biobanks and other research initiatives. The integration of artificial intelligence (AI) and big data analytics is expected to play a transformative role in unlocking the potential of this data, driving breakthroughs in personalized medicine and public health strategies. However, to fully realize this opportunity, organizations must overcome hurdles such as ensuring robust data protection, complying with evolving regulatory frameworks, and addressing privacy concerns, all of which add complexity to the development and deployment of genomic medicine in the region.

INFRASTRUCTURE AND TECHNOLOGICAL NEEDS

The Middle East has made strides in advancing genomic medicine, yet further investments in infrastructure and technology are essential to fully unlock its potential. The vast amounts of genomic data generated necessitate secure and scalable storage solutions. Investments in biobanks, cloud storage systems, and blockchain technology for data integrity are critical. With the increasing use of genomic data, governments must also establish clear regulatory frameworks to address privacy, data sharing, and cybersecurity concerns.

Advanced sequencing facilities are also becoming increasingly important. Expanding access to next-generation sequencing (NGS) technologies will allow for faster and cost-effective genome analysis. Investments in cutting-edge sequencing centers are essential to scale research and clinical applications. Meanwhile, facilities like robotic biobanks, such as the one in Dubai, streamline sample storage and retrieval, enhancing efficiency for large-scale research.

In the context of infrastructure and technological needs for genomic medicine in the Middle East, population-level genetic screening—whether through limited or expanded gene panels—remains underdeveloped. While cytogenetic services, such as traditional karyotyping and fluorescence in situ hybridization (FISH), are now widely available in major hospitals, a gradual shift toward advanced techniques like molecular karyotyping and chromosomal microarrays has begun in several centers. However, a significant gap exists in the region's clinical genomic-sequencing capabilities. Cost-effective NGS technology has revolutionized clinical genetic testing by enabling comprehensive approaches, such as large-scale gene panels and whole exome sequencing, which are particularly effective for diagnosing highly heterogeneous genetic disorders. This technology also underpins non-invasive prenatal testing (NIPT) for detecting trisomies in high-risk pregnancies. Despite growing demand, local capacity for NGS-based testing remains insufficient, with many Middle Eastern countries relying on reference laboratories in Europe and the United States to meet their needs. Bridging this gap will require investment in NGS facilities, training, and infrastructure to support a robust local genomics ecosystem.

The Middle East faces a significant talent shortage in genomic medicine due to the longstanding brain drain, with professionals often seeking opportunities abroad. This has resulted in a scarcity of clinical molecular geneticists, bioinformaticians, and genomic analysts, essential for operating advanced genomic testing platforms that require expertise in both complex laboratory processes and large-scale data interpretation. As of 2018, the region had only 11 board-certified clinical molecular geneticists (0.02 per million population), compared to 632 in the U.S. (~2 per million population), highlighting the gap in expertise.

Promoting cross-border partnerships will facilitate the sharing of resources, expertise, and data. Joint efforts can help pool genomic information to address region-specific health challenges. Collaborations with global technology firms and pharmaceutical companies can bring cutting-edge tools and funding to accelerate progress.

Linking genomic data with electronic health records (EHRs) will enable personalized medicine and population health management.

Ensuring equitable access to genomic technologies across different demographics and regions will be critical to achieving widespread benefits. At the same time, addressing issues like consent, genetic discrimination, and equity is essential for the responsible implementation of genomic medicine. In the context of equitable access to genomics in the Middle East, it is crucial to differentiate between democratizing global human genomic research and ensuring that the benefits of genomic advancements are integrated into local healthcare systems. While the former involves fostering inclusivity in research efforts and data representation, the latter requires targeted decision-making and policy development to translate genomic knowledge into tangible healthcare improvements for local populations. Both aspects demand distinct strategies and levels of commitment from policymakers and stakeholders to achieve meaningful outcomes.

Advanced algorithms are also needed to analyze and interpret genomic data, identify patterns, and develop personalized treatment plans. At the same time, high-performance computing systems capable of managing and processing complex datasets will be key to supporting AI-driven insights and real-time analysis.

FUTURE OUTLOOK AND RECOMMENDATIONS

The future outlook for genomics in the Middle East shows strong momentum as both public and private sectors explore a wide array of biotechnology applications across the healthcare and wellness value chain. This trend is reflected in the growing interest in AI/ML-powered digital health solutions, particularly in precision healthcare. Innovations like CAR-T cell therapy, companion diagnostics, and targeted therapies in oncology, driven by genomic data, are advancing the treatment of specific patient populations. These developments are fostering new business models that emphasize collaboration across the healthcare ecosystem, essential for the successful deployment of novel preventive and curative approaches.

Emerging treatment paradigms, such as gene editing with CRISPR-Cas9, are opening new frontiers in personalized medicine, offering cures for previously untreatable conditions like cancer and rare genetic disorders. Likewise, advancements in gene therapy, cell therapy, and immunotherapy are shifting focus from mortality to improving the quality of life, with significant implications for healthcare providers, developers, payors, and patients.

With next-generation sequencing (NGS) technologies making rapid progress, the future of genomics is on track to include routine genome analysis in laboratories. Additionally, large-scale data collection from various biological sources, such as proteomics, metabolomics, and transcriptomics, is set to provide valuable insights into disease development and treatment outcomes. The integration of AI and machine learning into genomic data analysis is another key trend, with many start-ups focusing on this promising segment of the healthcare landscape.

Saudi Arabia and the UAE are positioned to dominate the genomics market in the Middle East and Africa, projected to account for over 60% of the estimated \$1.2 billion market value.

In Saudi Arabia, 8% of newborns are diagnosed with genetic disorders. Additionally, Saudi Arabia, the UAE, and Qatar rank 2nd, 6th, and 16th globally in prevalence. Leveraging genomic data offers these countries significant opportunities to enhance the prevention, diagnosis, and treatment of such conditions.

The high prevalence of genetic disorders in Saudi Arabia, the UAE, and Qatar underscores the critical importance of genomic research in these nations. While genomic data presents immense potential for improving healthcare outcomes, the challenge for Gulf States lies in transforming their expertise in data collection into advanced analytical capabilities. Successfully extracting value from genomic data will not only enhance their ability to prevent, diagnose, and treat genetic conditions but also position these countries to foster strategic partnerships and bolster local competencies in biotechnology and AI. This shift from data accumulation to value creation could serve as a foundation for establishing globally competitive innovation ecosystems.



CONCLUSION

The Middle East is uniquely positioned to become a leader in genomic medicine, leveraging its strategic investments, burgeoning research capabilities, and growing genomic initiatives. However, realizing this potential requires addressing key challenges, including talent shortages, equitable access, and the integration of advanced infrastructure and technologies. By fostering international collaborations, building local expertise, and developing robust regulatory frameworks, the region can not only improve healthcare outcomes for its population but also establish itself as a pivotal player in the global genomics landscape. A unified and strategic approach to genomics holds the promise of transforming public health and economic opportunities, driving the Middle East toward a future where precision medicine is both innovative and accessible.



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