Pharmacoeconomic Analysis of Telemedicine and Digital Health Initiatives in Saudi Arabia

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Abstract

Telemedicine has transformed the delivery of healthcare in Saudi Arabia by making health services more accessible, particularly in the interior parts, and lowering health care costs. The proactive steps taken by the Saudi government and healthcare providers in the integration of telemedicine into healthcare have given a more solid basis for long-term savings and greater improvements in treatment of patients. Telemedicine and digital health initiatives have helped in Saudi Arabia positively impact adherence to medication and disease management costs for patients with chronic conditions. Such initiatives foster frequent follow-ups and advising, which enhance patient involvement and adherence and then lead to reductions in healthcare costs. This review article how telemedicine was implemented under the Vision 2030 initiative as part of the Saudi Healthcare Framework and the effects it has on healthcare cost containment, patient outcomes, and other related challenges like infrastructure barriers and cultural attitudes. Findings indicate that telemedicine saves travel costs, improves resource utilization, and helps in the management of NCDs with benefits for the country's economic and health dimensions.

Keywords: Telemedicine, Pharmacoeconomics, Saudi Arabia, Vision 2030, Healthcare Efficiency, Digital Health, Non-Communicable Diseases (NCDs).

1. Introduction

The integration of telemedicine and digital health into the Saudi healthcare system has produced substantial cost-saving outcomes, which can be explained by several factors, including improved accessibility, reduced traveling costs, and efficiency improvements in healthcare delivery. Telemedicine has enhanced accessibility for many patients, mainly those in rural areas. Telemedicine decreases the requisite travel distance for getting health care services as it allows remote consultations. This means that patients do not have to spend a lot of time and money traveling for health care services. According to a study, telemedicine cut transportation time and decreased the potential number of inpatient visits, thus saving costs connected to travel and lost productivity (Al-Hazmi et al., 2021). Moreover, studies indicate that telemedicine saves the cost of companions on the part of a patient, especially on children and people with disabilities, as they often need assistance in approaching the physician during consultation (Al-Hazmi et al., 2021). In Saudi Arabia, this is crucial because it involves geographical access to healthcare services.

Telemedicine has been associated with increased efficient usage of healthcare resources. During the COVID-19 pandemic, the expansion of services in telehealth allowed healthcare providers to better handle their patient loads, hence optimizing the use of available resources by managing patient loads effectively (Alwabili et al., 2021). This transition, in turn, not only helped solve overcrowding in emergency departments but made sure patients receive timely care, as opposed to the usual delays with conventional in-office visits (Alfaleh et al., 2022). Efficiency savings of telemedicine can be stretched into a cost-cutting health system as there will be fewer demands on physical infrastructures and operational costs tied to it (Mohaya et al., 2021).

Third, the Saudi Ministry of Health has aggressively marketed telemedicine as part of its Vision 2030 program, which is an effort at digital transformation to upgrade healthcare delivery (Mutair, 2023). This strategic focus has given way to developing several telehealth applications, including Mawid and Sehha, which may expedite appointment bookings and virtual consultations (Kheir et al., 2022). Widespread adoption of these technologies not only improves patient satisfaction but also makes them cost-effective by avoiding unnecessary in-person visits and the associated costs, according to Nasser et al. (2021).

2. The Impact of Telemedicine on Healthcare Accessibility and Economic Efficiency in Saudi Arabia

Saudi Arabia experienced a huge positive impact on access to healthcare through the widespread utilization of telemedicine. Again, this increase in health care accessibility is attributed to the necessity of closing the gap in health care which has, historically been significant in remote communities who lack access to specialists and specialized care in time. Telemedicine was implemented to expand access to healthcare in rural and remote communities. Literature studies reveal that telemedicine makes it possible for patients to consult at the right time as they are relieved from having to travel for long distances which incurs not only time but financial costs

as well (Albaghdadi, 2023). The virtual consultations have been very beneficial especially in patients living in underserved areas where healthcare facilities might be scarce or lacking specialized care (Alqurashi, 2023). Additionally, the proactive steps by the Saudi healthcare system to introduce telehealth services prior to COVID-19 created a strong platform for its acceptance at breakneck speeds when the crisis had been formed, thus increasing access to healthcare services (Alqurashi, 2023).

Economic Considerations of Telemedicine Availability Expanding the availability of telemedicine has multiple economic implications in a trilateral sense. Telemedicine saves the need to travel by reducing potential savings to the patient but also releases pressure to healthcare facilities, thus becoming resource-use efficient (Bashir et al., 2023). For example, studies show that telemedicine saves due to overall cost reduction through healthcare, hence saving unnecessary face-to-face meetings and saves time effectively from healthcare providers (Mohaya et al., 2021). Telemedicine has also been found to improve outcomes in patients because of early diagnosis and treatment such that severe health challenges are avoided that would require costly interventions later (Hassounah et al., 2020).

Additionally, the Saudi government has acknowledged the economic dimension of telemedicine as part of its plan to implement Vision 2030 to digitize healthcare services as well as to improve overall health system efficiency (Aboregela, 2023). It has also led to the launching of several telehealth platforms through which the application, Sehha, has made healthcare services easily accessible to all citizens, especially for those dwelling in remote places (Adly et al., 2020). The economic effects of this access, therefore, are very significant, for they enhance patient satisfaction while contributing to a more sustainable healthcare model that can accommodate the needs of a diverse population (Mohamed, 2023).

In conclusion, telemedicine adoption in Saudi Arabia has significantly enhanced access to health care services for rural and underserved populations, hence a significant cost advantage. Timely access to health care and resource use optimization thus characterizes telemedicine as an important step forward in the Saudi health care system in support of national objectives for better health outcomes and economic efficiency.

3. The Evolving Digital Health Landscape in Saudi Arabia: Accessibility and Pharmacoeconomic Benefits

The digital health landscape of Saudi Arabia has significantly changed, particularly with the integration of telemedicine and various health applications. These initiatives have improved the accessibility of healthcare and have indicated pharmacoeconomic benefits across various patient demographics. The most frequently used digital health initiatives of Saudi Arabia are telemedicine platforms that include the Sehha application and the Saudi Telehealth Network (STN). These services, however, allow for remote consultations from the comfort of home, meaning that patients no longer need to visit healthcare facilities Albaghdadi (2023), Alsubaie, 2023). Such software, like the Sehha app, helps manage the appointment of patients and provide remote consultations, which in turn enhances healthcare delivery Alsubaie, 2023. The STN was

also implemented with the view of enhancing the quality of healthcare services and increase access, especially for people living in rural and under-served areas Alsubaie, 2023).

The economic benefits of these digital health strategies differ significantly across different patient demographics (Table 1). For example, studies have indicated that the benefit for telemedicine is considerably vast in patients residing in rural areas due to decreased travel costs and time spent accessing healthcare services (Nasser et al., 2021). This is very important to a country like Saudi Arabia since geographical barriers can prevent access to healthcare services. It also saves on in-person visits, which, at times, are very unkind to patients, especially the elderly, as well as people who are chronic and need constant monitoring (Tourkmani et al., 2021).

The pharmacoeconomic benefits are also determined by the type of healthcare services used. Telemedicine is excellent in chronic diseases, such as diabetes and hypertension, which require regular follow-ups to manage the disease in its residual state (Tourkmani et al., 2021). A study shows that people with uncontrolled type 2 diabetes who received telemedicine services had better health outcomes, and this may minimize the long-term healthcare costs of complications from the disorder (Tourkmani et al., 2021). This in turn suggests that economic benefits of telemedicine are not only about direct cost but about how they translate to the long-run health impacts and reduced health expenditures.

The impact of demographics, such as age and socioeconomic status, and health literacy, varies with the success and adaptation level of the digital health initiatives. Younger patients and individuals with higher levels of health literacy tend to be more receptive to telemedicine, thus showing higher satisfaction rates and better health outcomes (Assiri et al., 2021; Kaliyadan et al., 2020). Older patients or those with lower health literacy may find it difficult to use such technologies, thus hindering their access to the corresponding economic benefits (Alajwari et al., 2021). In conclusion, digital health initiatives, especially telemedicine, have greatly enhanced the accessibility of care within Saudi Arabia. The different patient demographics portrayed varied pharmacoeconomic benefits. While such programs help realize substantial savings in terms of cost and improved health outcomes, the effectiveness varies, primarily due to demographic factors that must be considered for maximal effect.

Table 1: Key benefits of Telemedicine in Saudi Arabia.

Sr. No	Category	Details	Sources
1	Cost Savings	Reduced travel expenses, fewer hospital visits, and optimized resource use.	Al-Hazmi et al., 2021
2	Improved Accessibility	Easier healthcare access in remote areas through virtual consultations.	Kheir et al., 2022
3	Efficiency Gains	Decreased crowding in hospitals and better disease management.	Alfaleh et al., 2022
4	Chronic Disease Care	Enhanced monitoring and medication adherence for diseases like diabetes and hypertension.	Tourkmani et al., 2021

4. The Role of Telemedicine in Enhancing Medication Adherence and Reducing Disease Management Costs in Saudi Arabia

The telemedicine and digital health programs of Saudi Arabia have had a considerable impact on medication adherence and disease management costs for the patients with chronic conditions. Better access has been provided to healthcare while improving adherence to medication and lowering the overall healthcare cost. Telemedicine platforms of which the Sehha application and other telehealth services have become powerful tools to promote adherence to medication regimens in patients. Nevertheless, there is evidence that telemedicine enables regular follow-up consultations for patients with chronic conditions like diabetes, hypertension, and osteoporosis. Albaghdadi (2023), Mutair, 2023). For example, a study on patients with type II diabetes in Khobar City found that the rates of medication adherence increased through telemedicine interventions because of timely reminders and health care provider counseling available to patients (Alqarni et al., 2019). Other studies have pointed out that telemedicine influences the ability to continuously communicate between teams of health care providers and patients, which is essential for the implementation of health care interventions (Alsadhan et al., 2022).

Moreover, the economic impact of these digital health initiatives is noteworthy. Improving medication adherence by telemedicine can prevent complications that are often related to chronic diseases, thereby increasing health costs. For instance, it will be difficult for a patient adhering to the prescribed medications to endure severe health crises leading to hospitalization, and overall management costs of the disease will be decreased (Aboregela, 2023). Such a study revealed that adherence rates to osteoporosis medications were equivalent for telemedicine and in-clinic consultation visits and thus demonstrated how the mode of interaction did not compromise the quality of care (Alsadhan et al., 2022). This means that this could be a cost-effective alternative mode of healthcare service delivery, especially pertaining to chronic disease management.

Besides, the efficacy of these digital health initiatives is influenced by other demographic factors. Younger patients and high health literacy levels benefit more from telemedicine because they tend to embrace digital devices while also understanding the consequences of non-adherence to medications (Kheir et al., 2022). In contrast, older patients or those with low health literacy might find it difficult to use such technologies, thus impairing their adherence rates and disease management in general (Adly et al., 2020). Hence, targeted educational interventions may be an important requirement to ensure all patient demographics can effectively use telemedicine services. The problem for these technologies, however, is demographic inequalities of access and comprehension of the technologies so that their benefits can be spread throughout the patient population.

5. Pharmacoeconomic Implications of Telemedicine Policies in Saudi Arabia

The benefits of the pharmacoeconomic implications of the regulatory and reimbursement policies of the Saudi Arabian telemedicine services include reduced costs, enhanced health outcomes among patients, and improved acss. In most instances, the Council of Cooperative Health Insurance introduced such policies largely because of the COVID-19 pandemic, where

the healthcare delivery in the country happens to be a determining factor. One of the more significant regulatory developments was CCHI approval of health policies that covered services such as telemedicine up to the end of the year 2021. This is an imperative step in the integration process that enables compensation for remote consultations among others in telehealth Mohaya, et. al (2021). The inclusion of telemedicine in health insurance coverage also brings reductions of out-of-pocket costs of a patient's side, which raises access to necessary care, especially in people who have chronic conditions that require follow-up treatments (Alqurashi, 2023).

Economic benefits of telemedicine are multidimensional. Telemedicine reduces the need for travel time, which can be expensive for patients not to mention for travel time, especially patients who hail from rural or less privileged areas (Alsahali, 2021). This is in the case of Saudi Arabia, which is among countries where geographical barriers can hinder access to healthcare services. Such studies have indicated that patients who implement telemedicine will show satisfaction levels that are significantly high because of the advantage of travelling that is reduced as telemedicine consultations are virtual (Albaghdadi, 2023; Alzahrani et al., 2023). Pharmacoeconomic benefits include better management of diseases and medication adherence. With telemedicine, healthcare providers can observe patients better, thus being able to manage chronic diseases such as diabetes and hypertension better. Improved medication adherence leads to the prevention of complications, hospitalizations, and lower healthcare cost in general (Kheir et al., 2022; Tourkmani et al., 2021). For example, chronic conditions patients using telemedicine are less likely to face serious health crisis events that require costly emergency care.

However, the effective utilization of telemedicine in Saudi Arabia is influenced by many factors; these factors include cultural attitudes and health literacy in the population (Alqurashi, 2023; Alsharabi, 2023). Patients who are young or who make heavy use of technology will have no qualms about embracing telemedicine. Older patients or those less knowledgeable about using digital devices may resist its adoption, thereby failing to provide maximal financial benefits for the services (Alqahtani et al., 2021). The drug policy and reimbursement of telemedicine in Saudi Arabia, therefore, poses very significant pharmacoeconomic implications. These policy approaches, in enhancing access to care, reducing costs associated with in-person visits, and consequently improving the quality of disease management, do lead to an efficient health system. Most importantly, the elimination of demographic disparities and promotion of equality among all patient groups could effectively utilize telemedicine services to enhance these benefits.

6. Evaluating the Return on Investment (ROI) of Telemedicine Programs Under Saudi Arabia's Vision 2030

The Riyadh Initiative is a complex matter when it comes to the ROI of the telemedicine programs implemented under Saudi Arabia's Vision 2030 health initiatives, with emphasis on various aspects of economic improvements, social changes, and improvement in health care delivery service. The latest framework of Vision 2030 has impressed the nationwide introduction of telemedicine to greatly enhance the access, efficiency, and quality of health care delivery (Figure 1).

The main economic benefit telemedicine offers are the reduction of healthcare costs. Telemedicine reduces the need for in-person visits, which can sometimes be expensive to patients as well as the health systems. According to a study, telemedicine services have helped reduce traveling expenses and time lost at work from patients; therefore, they have saved them money Nasser et al. (2021). This is particularly useful in rural settings where access to hospitals might be scarce and costly (Alamri et al., 2022). The Saudi Ministry of Health (MOH) has been a strong proponent of telemedicine as a method of increasing access to healthcare, primarily during the COVID-19 period that increased the usage of telemedicine (Alajwari et al., 2021).

In addition, the use of telemedicine has been linked to increased patient satisfaction and health results. It has been discovered that telemedicine patients provide a high satisfaction quotient since services accommodate comfort and accessibility (Alsharabi, 2023). Patient engagement and adherence to treatment plans increase, and these are associated with a positive correlation to health outcomes; hence, long-term healthcare costs of chronic conditions continue to reduce (Alqurashi, 2023). For example, telemedicine is especially useful for chronic diseases such as diabetes, which require regular monitoring and follow-up (Alqurashi, 2023).

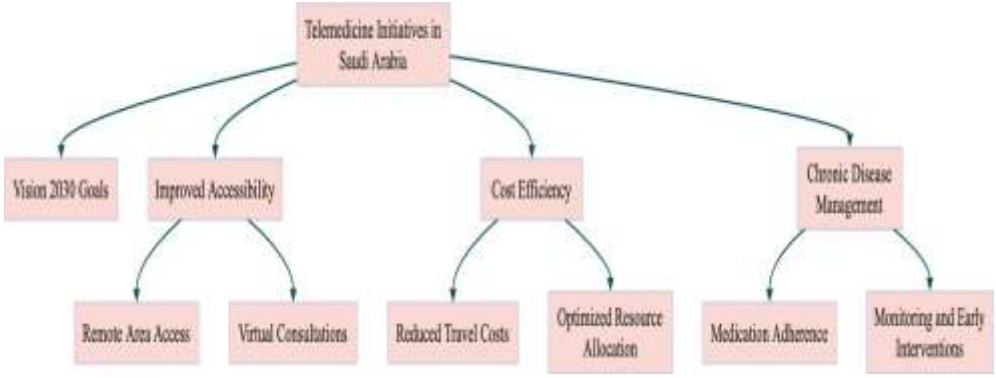

Figure 1. This diagram outlines the pivotal role of telemedicine in Saudi Arabia, aligned with Vision 2030 goals. The initiatives aim to improve accessibility through remote area access and virtual consultations, enhance cost efficiency by reducing travel expenses and optimizing resource allocation, and support chronic disease management by fostering medication adherence and enabling early interventions.

The efficiency of healthcare service delivery is also reflected in the return on investment from the telemedicine program. In telemedicine, health service providers can use their time more effectively, thus seeing more patients within a shorter period compared to face-to-face consultations (Albaghdadi, 2023). This productivity gain, for example, can result in a higher throughput of patients, thus contributing to the sustainability of healthcare facilities financially (Alsahali, 2021). Moreover, the adoption of telemedicine towards the rejuvenation of the health sector is in line with the main expectations of Vision 2030 whereby the health services should be digitalized and public health outcomes enhanced (Alajwari et al., 2021).

This notwithstanding, a concern is that several challenges and barriers would impact the ROI of telemedicine programs. There are issues such as technological literacy and cultural acceptance, to mention a few, that influence the impacts of telemedicine services (Li et al., 2020). Overcoming the mentioned hindrances would be crucial for making the most out of telemedicine and ensuring it adds value to the healthcare delivery system.

7. Cost Savings and Enhanced Patient Experiences in Telemedicine

There is comprehensive empirical proof that cost savings are associated with positive patient experiences and outcomes in telemedicine, though various studies underscore that telehealth intervention brings forth economic benefits. Benefits of these interventions usually arise from medication adherence, a reduction in travel cost, and increased overall patient satisfaction. One high-impact study by Xu et al. proved the possibility that telemedicine could yield enormous cost savings to a healthcare system. For example, after introducing telemedicine in rural hospital emergency departments, there was an overall reduction in expenditures from $7.6 million to $1.1 million in five years without compromising clinical outcomes Xu et al. (2018). This demonstrates the use of telemedicine to reduce costs of running while quality care is maintained.

Moreover, a systematic review by Atmojo et al. also suggests the economic benefits of telemedicine. According to them, not only does telemedicine enhance health service outcomes but also satisfies the patient by saving time for traveling, increasing the interval between direct visits, and minimising transportation costs (Atmojo et al., 2020). These elements facilitate a more efficient model of health care delivery that may positively impact patients' and healthcare providers' cost envelope. In addition, Choi et al. underscored that interventions designed to improve adherence to medication through telemedicine can compensate for high drug costs by decreasing inpatient and outpatient healthcare cost burdens (Choi et al., 2023). This is particularly pertinent for chronic disease management, where consistent adherence to medication is critical in preventing complications that make their way to costly hospitalizations.

Thee et al. describes a randomized controlled trial with cystic fibrosis patients and reports telemedicine could help save up to €5,000 per patient yearly (Thee et al., 2021). This would mean that telemedicine not only is of clinical value but also financially lucrative for the healthcare sector compared to other settings. In the field of pain management, Jalilian et al. found that a telemedicine-based approach reduced travel distance and cost for patients, which led to high satisfaction rates among those surveyed (Jalilian et al., 2022). This goes on to show how telehealth can augment patient experiences while simultaneously bringing down expenses for patients.

Furthermore, Ramaswamy et al. indicated that telemedicine consultations conducted during the COVID-19 pandemic were associated with the cost-effective and high patient satisfaction exercises, accentuating the fact that telehealth is a cost-effective means for delivering health care services (Ramaswamy et al., 2020). Overall, it appears that telemedicine improves patient experiences and outcomes while also bringing cost savings not only to the healthcare system but also directly to patients. Telehealth initiatives enhance drug adherence; reduce travel costs,

which most travel arrangements bear in line with current healthcare systems; and ensure that patients are satisfactorily satisfied with services received.

8. Cost Barriers to Telemedicine Implementation in Saudi Arabia Under Vision 2030

The cost barriers of infrastructural and training nature are associated with the adoption of telemedicine in Saudi Arabia, especially in the scope of Vision 2030 health initiatives. These can all contribute to substantial hindrances within the effective adoption and utilization of telehealth services (Table 2).

Infrastructure Barriers

1. Technological Infrastructure: The limitation in implementing telemedicine is associated with poor technology infrastructure, slow internet speed, and the machines. Most health facilities are the least privileged in rural areas and lack proper access to the internet, which is a basic constituent for effective provision of telemedicine (Assaye, 2023, Ashry & Alsawy, 2020). According to Dubin et al., this access significantly affects patient consultation, mainly due to poor audio quality and disparities in internet access that would undermine the efficacy of telemedicine even among patients who may not speak a particular language utilized in the consultations (Dubin et al., 2020). This technological gap leads to inequity in health care access and results.

2. Funding Limitations: The set-up costs of telemedicine infrastructure would be very expensive due to the cost of capital, which would involve purchasing a computer, software, and other equipment. Ashry and Alsawy noted that there is a challenge for telemedicine projects in developing countries such as Saudi Arabia because they lacked proper funding and infrastructure (Ashry & Alsawy, 2020). This financial barrier may hold up the scale of expansion of telehealth services and prolong the rollout of the service.

Training obstacles

1. Provider Training: Telemedicine cannot be suitably applied to reality in the proper application of telehealth technologies if healthcare professionals are not properly trained. According to research carried out by Assaye, "no provider training on telemedicine has a high impact for healthcare provider perceptions and willingness" (Assaye, 2023). According to a systematic review, there is a big need for continuous training of health care professionals to get them self-sufficient and confident when utilizing these platforms (AlKhanbashi & Zedan, 2022).

2. Patient Training and Comfort: The success of telemedicine further rests on the patients' ability to move around the technology. According to Lindenfeld et al., training for the patient and provider forms an integral part of ensuring the appropriateness and success of telemedicine (Lindenfeld et al., 2022). Without proper comfort using the technology, patients may end up being less likely to engage with telehealth services, which in turn would limit the plausible benefits that might arise from such initiatives.

3. Cultural and Socioeconomic Factors: Cultural beliefs concerning the adoption of technology and health practices can be a barrier. Aboalshamat stated, for instance, that lack of trust in

electronic business and privacy issues are influences that may impact user uptake of telehealth services in Saudi Arabia (Aboalshamat, 2020). This also involves cultural factors that require training and sensitization in communities to overcome objections towards telemedicine.

In a nutshell, the most expensive barriers to the implementation of telemedicine in Saudi Arabia fall under the Vision 2030 healthcare programs regarding inadequate infrastructure and insufficient training among healthcare providers and patients. Therefore, strategic investments in technologies and holistic training will lay down the foundation for maximizing telemedicine in improving access to, and outcomes of, healthcare across the country.

Table 2: Barriers to Telemedicine Implementation.

Sr. No	Category	Details	Sources
1	Infrastructure Challenges	Poor internet connectivity in rural areas and insufficient technological investment.	Ashry & Alsawy, 2020
2	Training Gaps	Lack of telemedicine training for healthcare providers and patients.	Assaye, 2023
3	Cultural Factors	Distrust in digital systems and resistance to change.	Aboalshamat, 2020

9. Cost Savings and Economic Efficiencies of Telemedicine in Mental Health Care

Telemedicine in mental health care has been related to certain cost savings and improved economic efficiencies, where these tend to be noticed primarily through increased access to services, avoided travel costs, and increased patient satisfaction. Several studies support these benefits.

1. Cost savings from decreased travel and time. Telemedicine saves patients the time and cost of traveling to appointments, which is an especially useful phenomenon for mentally ill patients. A systematic review by Hatami et al. pointed out that it saves travel-related expenditures and time, which are also advantageous to the patients themselves Hatami et al. (2022). This is particularly helpful to those staying in rural setups where the services of mental health practitioners are scarce. The curtailment of travel saves money for the patients while, on the other hand, decreasing the burden on the healthcare system through a reduction in missed appointments and increased attendance levels (Salsabilla et al., 2021).

2. Access and Utilization: Access to mental health services has been increased through telemedicine, especially to marginalized communities. In a scoping review by Abraham et al., the use of telemental health significantly reduces barriers to access and is more prevalent than traditionally underserved communities that include refugees and rural dwellers (Abraham et al., 2021). Telemedicine will enable earlier intervention and treatment that might reduce the long-term costs of untreated conditions in mental health and, therefore, improve access.

3. Patient Satisfaction and Retention: Several studies have shown that patients have high levels of satisfaction in telemedicine for mental health care. An example is Labelle et al. who

discovered that patients receiving telepsychiatry received similarity treatment outcomes as clients getting regular in-person visits, with similar levels of satisfaction (LaBelle et al., 2018). Sustained treatment has benefits in terms of higher retention rates in treatment programs, economically speaking, with lower dropout- management costs and less expenditure on recruiting a new client.

4. Economic Evaluation of the Telehealth Interventions: In its systematic review, Díez et al underlined that telemedicine is more cost-effective than face-to-face encounters. The review pointed out that health outcomes in the intervention groups are the same or better and less costly, particularly in mental health settings (Díez et al., 2015). In addition, Xu et al conclude that, there exist remarkable cost savings through the utilization of telemedicine across all healthcare settings, inclusive of mental health service areas (Xu et al., 2018).

5. Clinical Effectiveness and Cost-Utility: Morriss et al. carried out a randomized controlled trial that established the fact that the remotely delivered CBT is economically dominant, providing a net monetary benefit per participant (Morriss et al., 2019). Such a study implies not only that telemedicine improves clinical outcomes but that it can offer substantial cost savings, strengthening the economic feasibility of the telehealth model of mental health care.

6. Overall Economic Impact. Overall, telemedicine in mental care could potentially have a large economic impact. Adepoju et al. present a research paper stating that telemedicine costs less to the patient: 355 per year, compared to an in-person care cost of $1,166 (2022). This gives a possibility for reducing the amount of healthcare expenditure while maintaining its quality with telehealth.

In conclusion, the proof confirms that telemedicine in mental health care is a desirable solution associated with both cost saving and economic efficiency. Such programs reduce travel costs while increasing access and enhancing patient satisfaction; in this regard, telehealth becomes an appealing solution for addressing mental health needs at optimized healthcare expenditures.

10. The Role of Digital Health Tools in Supporting Preventive Care in Saudi Arabia

Digital health tools, mainly through such initiatives as easy access to healthcare services, greater patient engagement, and therefore a reduction in hospital admissions and visits to the emergency service, play a pivotal role in supporting preventive care in Saudi Arabia. Their economic benefits, related to such outcomes, are multifaceted and very considerable.

Support to Preventive Care

1. Better Accessibility to the Service Offerings: Digital health platforms, starting with the Sehha application and the telemedicine services, have helped to make more accessible the healthcare for the populations that live far from urban centers or receive limited services. Patients can see medical professionals without traveling; thus, the use of such channels benefits preventive care immensely through check-ups or screenings (Mani, 2024, Hassounah et al., 2020). The tools encourage patients to seek preventive services, which may take them towards early detection and management of health issues by availing themselves easier to healthcare facilities.

2. Patient Participation and Education: Digital health technology also enhances patient participation by educative means and reminding notifications in preventive care activities like vaccination and health check-up activities. For instance, health applications were employed to educate patients on dates for vaccination or screening that greatly aids in improving participation in preventive health care practices (Nasser et al., 2021). It also helps to manage chronic diseases, thus preventing complications that eventually result in admission in a hospital.

3. Telemedicine in the Prevention Care of Mental Health With time, there is promise with integrating telemedicine in preventive care. Perhaps patients can receive timely care for their mental health conditions remotely instead of escalating into stages where emergency interventions may be required (Althumairi et al., 2022). With the mounting concerns over mental health, there is a lot of relevance to the backdrop of COVID-19 too.

11. Economic Gains

1. Reduced Rates of Hospital Admission: Growth in preventive care and availability of routine health services via online health platforms could reduce the hospitalization rate substantially. For instance, Alfaleh et al. cited the point that with the provision of telemedicine services, there will be an effective reduction in presentations at the emergency departments, especially in non-urgent cases (Alfaleh et al., 2022). In this respect, reduced admission rates to the health facilities ease congestion while, at the same time, the health sector realizes enormous economic advantages.

2. Emergency Visits Cost Savings: Avoidance of emergencies has great economic consequences. Telemedicine, more generally, digital health interventions are likely to reduce visits in emergency departments that are costly and heavy utilization also. A systematic review, it has been demonstrated that telemedicine intervention is instrumental in cost savings on sufficient scale through decrease in unscheduled emergency visits and hospital admissions (Mohamed, 2023;, Alghamdi et al., 2021). For example, an emergency room visit may run between $1,000 and $3,000. Telemedicine visits are significantly less expensive than this, so there is a bright economic payoff (Alanzi, 2021).

3. Better Resource Use Digital health technology can help the healthcare sector to make better use of its resources. It may help reduce the load of minor, not-so-emergency cases at emergency departments and allocate health care to those who need it the most, which consequently increases the efficiency and effectiveness of the services provided (Hassounah et al., 2020). Health care facilities would be sure to use resources more efficiently and their operational costs will be lower.

4. Sustainability into Long-Term Economics: With digital health technologies within the care pathway, this will increase the country's economic sustainability to contribute towards Vision 2030, having in mind the quality of health services and the economical aspect of which people can expect. Long-term healthcare cost savings from reduced chronic disease management and lower hospitalization form part of the resulting healthier population and a more efficient healthcare system (Mani, 2024; Alhur, 2024).

Therefore, Saudi Arabia's digital health tools greatly contribute to preventive care in the following ways: better provision of services, improved patient engagement, fewer admissions and emergency visits, and more associated dollars savings as a result from avoiding emergency visits and better utilization of resources. Going forward, these tools will be integral to achieving better health outcomes and economic efficiencies as Saudi Arabia expands its policy on digital health.

12. Pharmacoeconomic Implications of Telemedicine in Managing Non-Communicable Diseases (NCDs) in Saudi Arabia

The financial implications of telemedicine for the control of NCDs in Saudi Arabia are very important; they involve the above aspects, including savings, better health outcomes, and efficient healthcare. Since NCDs in general, including diabetes, cardiovascular diseases, and chronic respiratory diseases, are huge burden factors on the Saudi health system, utilizing telemedicine provides a feasible solution to such a problem.

Cost Saving

1. Reducing Hospital Admission: Telemedicine has been shown to reduce hospital admissions in patients suffering from NCDs to a great extent. With time-to-time monitoring and follow-up consultations, this technology has shown that it can manage chronic conditions very effectively and prevent complications- in a way common triggers for admission. A study by Tourkmani et al. showed that telemedicine interventions on patients with uncontrolled type 2 diabetes improved the management of their disease, thus reducing occasions for acute care and hospital admissions were reduced through this intervention Tourkmani et al. (2021). They would spend much less, saving doctor visits, with a good health care system for both parties.

2. Travel and Cost of Time: Telemedicine saves the time that patients must spend traveling to healthcare facilities; such clients mainly suffering from chronic health conditions. The cost of traveling is unbearably high, even in remote areas. It is here that telemedicine saves the time regarding the cost of transportation and absenteeism to work through e-consultations, hence reducing the general overall cost (Talmesany, 2023).

3. Better Medication Adherence: Telemedicine will ensure better intake of medicines for patients because it involves scheduling follow-ups and reminders, which are regarded as the mainstays of chronic disease management. Effective adherence is followed by improvements in health outcomes and averted costly complications resulting from non-adherence. A systematic review by Díez et al. reported that telemedicine interventions have similar or better health outcomes and are potentially less costly than traditional care (Díez et al., 2015). Of course, this cost-effectiveness is most relevant for the management of NCDs, because regular drug use often prevents the progression of disease.

13. Better Health Outcome

1. Early Detection and Treatment: Telemedicine will also open doors for early detection of health problems through regular check-in and follow-up consultations. Early handling of diseases in time saves the long-term expense of expensive management of advanced diseases. According to Alharbi et al., technologies in telehealth are expected to solve existing issues of the healthcare system like long waiting hours and lack of resources that positively affect the outcomes of treatment with patients (Alharbi et al., 2021).

2. More Patient Engagement Digital health technologies encourage greater patient engagement because they provide readily accessible and uncomplicated means of getting hold of health information and resources. Greater engagement may be correlated with better self-management of chronic conditions, an important precursor of the prevention of complications and reduction of healthcare costs. In fact, a study by Alajwari et al. even indicated that telemedicine significantly improved patients' knowledge and attitudes about the management of their health, which is fundamental for NCD management (Alajwari et al., 2021).

14. Economic Efficiency

1. Resource allocation: With telemedicine, the non-urgent cases that present at emergency departments reduce the burden. Healthcare providers can therefore optimally allocate available resources efficiently. Optimization may lead to improved healthcare delivery and reduced operational costs for healthcare facilities (Alfaleh et al., 2022). Telehealth can efficiently manage more patients toward improving the entire process efficiency of healthcare.

2. Compliance with National Health Objectives: Implementation of telemedicine in the management of NCDs will be in line with Saudi Arabia's Vision 2030, which seeks to improve health care quality and accessibility. The investment in telehealth infrastructure can be seen to lighten the long-run economic burden of NCDs, estimated at US $24.4 billion annually (Aljarid, 2024). Therefore, cost investment is not only meeting the immediate needs of health care but is also for the sustainability of the health care system.

15. Pharmacoeconomic Lessons for Saudi Arabia from Global Telemedicine Experiences

Saudi Arabia can gain many practical lessons from worldwide pharmacoeconomic statistics on telemedicine on how to make its own digital health initiatives more cost-efficient, especially in the care of NCDs. The information below is based on a wide range of studies and analyses focusing on the economic savings and efficiencies gained through telemedicine.

Decrease in hospital admissions and visits to the emergency department

A global search has revealed that telemedicine cuts hospital admissions and emergency visits by a huge percentage, which are among the cost drivers in health care. For example, a massive UK Ministry of Health research study established that there is a 20% reduction in emergency hospitalizations for patients with NCDs when using telemedicine services (Fechina et al., 2022).

Saudi Arabia can replicate the telehealth models to boost its chronic care management program, thus easing hospital admissions and cutting healthcare costs.

Enhanced Patient Monitoring and Activation

Telemedicine enables constant patient monitoring, which is essential in the management of NCDs. A review of Japanese systematic studies explained that interventions through telemedicine resulted in patients being more activated and adherent to a treatment plan. This led to enhanced health outcomes and reduced healthcare costs (Akiyama & Yoo, 2016). Similar monitoring technologies can, therefore, improve compliance in Saudi Arabia and prevent complications and costly interventions.

Cost-effectiveness of telehealth interventions

Various studies across diverse countries have indeed established the cost-effectiveness of telemedicine over the traditional models of care. For instance, it has been reported that telemedicine in cardiovascular disease management is relatively cheaper compared to the one-on-one visit, considering the impact of the COVID-19 pandemic (Nugraheni et al., 2023). With such findings, Saudi Arabia can use these studies to justify investments in infrastructure for telemedicine, referring to short-term costs and long-term savings through lower hospitalization rates and better health outcomes.

Integration with existing health care systems.

Studies of successful telemedicine implementation in other countries have shown the significance of integrating telehealth services into an ongoing healthcare framework. There is a systematic review by Akiyama and Yoo that suggests that telemedicine should not be seen as a service itself but as part of a comprehensive healthcare delivery service (Akiyama & Yoo, 2016). Saudi Arabia can make its telemedicine initiatives stronger by making sure that they complement all the other existing services and thus make efficiency and increase patient satisfaction.

Promote Preventive Care

Telemedicine is associated with improved preventive care. The COVID-19 pandemic stimulated the use of telehealth for preventive services, including screening activities, as well as health education (Fechina et al., 2022). For Saudi Arabia, by promoting preventive care using telemedicine, it is possible to decrease the incidence of NCDs and their costs. This will contribute to the goals outlined in Vision 2030 of better public health in the country.

Overcoming Adoption Barriers

The global practice of telemedicine identifies barriers that include technological literacy, reimbursement, and regulatory in disincentivizing the uptake of telemedicine. For example, research indicates that lack of reimbursements for telehealth services constrains its use (Hassan et al., 2020). Saudi Arabia should develop clear policies and reimbursements models to encourage telemedicine as a mode of treatment for NCD management.

Data Utilization in Continuous Improvement

It allows for the monitoring of various variables associated with patients and cost expenditure from telemedicine projects. A notable study highlighted the need to gather economic data for assessment purposes regarding the sustainability and consequence of telemedicine on healthcare service provision (Whitacre, 2011). Saudi Arabia can establish sound data collection systems to gauge the efficiency of its telehealth programs, with appropriate changes and adjustments to the services offered constantly.

By drawing experience from worldwide pharmacoeconomic data related to telemedicine, Saudi Arabia can increase the cost-effectiveness of digital health programs. Focus should be given to reducing hospital admissions, to engage with patients, inclusion of telehealth into existing systems, preventative care, barriers to adoption, and use of data for continued improvement in optimizing telemedicine activities.

16. Conclusion

Telemedicine has emerged as one of the key cornerstones of the health reforms part of Saudi Arabia's Vision 2030. It helps in cutting costs through better chronic disease management and bridging the accesses; thus, it is both economically sound and healthy. Overcoming the infrastructure, training, and cross-cultural barriers are needed to maximize the potential. A strategic focus on telemedicine can give the Kingdom of Saudi Arabia a more equal and efficient way for the delivery of health care. Telemedicine, therefore, has taken profound pharmacoeconomic implications in the management of non-communicable diseases for Saudi Arabia. Reducing hospital admissions, savings travel costs, increases adherence to medicines, and increase patient involvement ensure that sufficient cost reductions with better health outcomes are realized. With the continued investment in the digital health programs of Saudi Arabia, the telemedicine model will be an essential approach for the address of the rising NCD burden and an efficient and sustainable healthcare system for that country. Overall, the telemedicine programs initiated under Saudi Arabia's health initiatives under Vision 2030 seem highly promising in terms of cost savings, patient satisfaction, and overall efficiency in healthcare delivery. As such, subsequent investments in digital health will have to be continuously evaluated and adapted to ensure long-term sustainability over time.

Conflict of Interest

Authors declare they don’t have any conflict of interest in personal, financial, or professional relationships.

Author contributions

All authors are involved in the data curation, manuscript writing, review & editing, corresponding author supervise the manuscript throughout the process and first given the idea and concept for study.

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