EFFECT OF ACCESS TO TELEMEDICINE SERVICES, PATIENT TECHNOLOGICAL COMPETENCE, AND INCOME LEVEL ON PATIENT OUTCOMES IN PAKISTAN

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ABSTRACT

Telemedicine is the revolutionized way of healthcare delivery that brings remote consultation and treatment possibilities with improved accessibility and convenience. This paper investigates the effect of telemedicine service quality on patient satisfaction and outcomes in remote locations. The research measures the important dimensions of reliability, responsiveness, empathy and technological competence using the framework of SERVQUAL. Results reveal that service quality has a large impact on both patient trust and engagement of telemedicine, with digital literacy being an important part to gain the most out of telemedicine. Despite significant technological access disparities, socioeconomically disadvantaged patients are challenged in this regard. The study emphasizes the importance that healthcare providers play in educating the public on the use of digital health, the improvement of telemedicine infrastructure as well as the delivery of a seamless user experience. In managerial implications, it is important to invest in simple technology, training programs, and internet that is reliable to maximize telehealth adoption. Long term telemedicine impact on the management of chronic disease should be the subject of future research, as well as exploring AI based solutions for enhancing service. Improving telemedicine strategies through addressing these aspects will help healthcare stakeholders develop equitable and efficient þatient care.

Keywords: Telemedicine, Patient Satisfaction, Service Quality, Digital Literacy, Healthcare Accessibility, Remote Healthcare.

INTRODUCTION

The development of digital technologies is fast, which has made telemedicine to become a transformational tool in modern healthcare (Ezeamii et al., 2024). The use of information and communication technologies to provide medical services remotely is termed telemedicine, which has revolutionized the patient care by providing patients' access to specialist consultations, monitoring of chronic conditions and timely interventions, especially in remote and underserved areas (Haleem et al., 2021). There are numerous studies that have shown the positive effect of telemedicine on patient outcomes such as

treatment adherence, reduce travel burden, and improved quality of care (Shaverdian et al., 2021). For example, in cardiology, advanced telemedicine systems have been an essential component for continuous patient monitoring and early complications detection thus improving the outcomes (Kędzierski et al., 2022). During the unprecedented challenges brought by the COVID 19 pandemic, the integration of telemedicine into the pace of mainstream healthcare further strengthened the area's role in maintaining care continuity as well as minimizing the infection risks (De Michieli et



al., 2022). While there are these rather notable advancements, there are various viewpoints in relation to the overall proficiency of telemedicine; some research indicates elevated levels of patient happiness and quality medical attention, whilst other studies may highlight deficiencies to the technological accessibility and end client capacity (Myllymäki et al. 2022; Cheng et al. 2021). That dynamic and evolving landscape highlights the importance of looking at how people – different people – reach out to, use of telemedicine services, and specifically, socioeconomic factors. technological proficiency or lack thereof (Tong et al., 2022).

Problem Statement

Despite telemedicine's promise of advances, there are numerous challenges which prevent adoption universal and effectiveness The (Waseem et al., 2022). uneven distribution of telemedicine resources is a major problem: there is lack of access to digital technologies as well as reliable internet in many rural and less advantaged areas (Zhu et al., 2022). The presence of this digital further compounds divide preexisting healthcare disparities (Tong et al. 2022), because the underprivileged patients, unable to benefit from timely remote consultations, nor continuous monitoring, may miss out on the advantages of such modality. Furthermore, patients have varying levels of technological competence that makes effective use of telemedicine platforms more complicated (Chua et al., 2022). While telemedicine has increased patient engagement and treatment adherence in well equipped settings, the critical knowledge gap on which benefits are extended to different income groups remains (Waseem et al., 2022). As barriers for telemedicine utilize by lower income patients include limited device access, low digital literacy, and financial constraints, lower income patients often face barriers to full utilization of telemedicine services (Zhu et al., 2022). Additionally, the majority of the research has been about telemedicine in general and has not taken into consideration the interaction between user competence and socioeconomic status (Ezeamii et al., 2024). In this study, the overall problem of

inequitable access, and the problem of technological competence of diverse income groups are addressed with the hope of providing a comprehensive analysis of the problem as it affects targeted interventions to make healthcare delivery more equitable (Ezeamii et al., 2024).

Student Aim and Objectives

This study aims to investigate how telemedicine access and patients' technological proficiency influence health outcomes among patients with Type I or Type II diabetes, and to explore disparities in telemedicine accessibility among various income groups.

Objectives:

1. To analyze the role of access to telemedicine services in improving patient health outcomes.

2. To evaluate the impact of patient technological competence on health outcomes.

3. To determine the variation in access to telemedicine services across income levels (low, moderate, high).

This study is driven by the need to bridge the technological gap between rapid advancements and their equitable application in healthcare (Haleem et al., 2021). As telemedicine becomes integral to healthcare delivery, it is crucial to understand both its benefits and the challenges that limit its effectiveness in diverse populations (De Michieli et al., 2022). The COVID-19 pandemic has accelerated telemedicine adoption, revealing its capacity to ensure continuity of care as well as its shortcomings in overcoming digital disparities (Cheng et al., 2021). By examining telemedicine access and patient technological competence, this study addresses a gap in research that has largely overlooked how socioeconomic status affects the implementation of telemedicine services (Tong et al., 2022). The findings are expected to provide practical insights for healthcare providers and policymakers, guiding the development of more inclusive telemedicine frameworks for all income groups (Waseem et al., 2022). Ultimately, this research will enhance our understanding of the interplay



between technology, user competence, and health outcomes, thereby promoting a fairer distribution of healthcare resources (Chua et al., 2022; Ezeamii et al., 2024). These crucial insights are vital for tailoring digital health strategies to community needs.

Literature Review

The SERVQUAL model provides a robust model to evaluate the service quality based on the expected service and the actual service provided to the patients (Wang et al., 2015). This model is especially useful in the context of telemedicine because it deconstructs quality into tangible, reliable, responsive, assuring, and empathetic elements essential for understanding patient satisfaction and overall health outcomes. As highlighted by Mason (2022), patient centered care is another important element that must be emphasised in order to deliver telemedicine services effectively, that is, both clinical efficacy and empathetic interaction with the patient must be in place to meet the patient's holisitc needs.

Preaux et al. (2023) developed such a conceptual model as they extended this concept by developing a conceptual model of the SERVQUAL dimensions as they apply to direct-to-consumer telemedicine consultations. This illustrates that а systematic evaluation of service quality can identify some critical areas of deficiency and strength in telemedicine platforms which can then be targeted to improve the service quality. In support of such a view, Hoque et al. (2021) demonstrated through empirical research that SERVQUAL is useful to assess telemedicine service quality and provide actionable insights in resource limited settings where otherwise delivering such services may be undermined by resource constraints.

Alabdali and Husain (2023) also proved further that the model is relevant through establishing a positive relationship between telemedicine platform quality and patient satisfaction and loyalty. Meng et al. (2024) also identified key factors of patient satisfaction with home based teleconsultations which leads to improved health outcomes, this includes reliable, responsive and empathetic service to the patient. The current study will systematically analyze which service quality dimension affects patient access to telemedicine and technological competence through the use of the SERVQUAL framework. It is an approach that both aligns with the study's goals and gives a more detailed picture of differences among income levels so that telemedicine services can be improved and patient outcomes enhanced through such targeted interventions.

Theoretical Development of Hypotheses

In recent years, there has been a great deal of attention paid to the relationship between telemedicine services and improved patient outcomes. Digital platforms that facilitate remote consultations, monitoring and between communication patients and healthcare providers are referred to as telemedicine (Ezeamii et al., 2024). Several studies have shown that telemedicine has the capacity to improve patient outcomes that include convenience of care, timely diagnosis, removal of barriers to travel, and patient engagement (Shorna, Sultana, & Hasan, 2024). However, it has also been proven that patient adherence to treatment plans can increase and that hospitalization can be reduced when chronic conditions can be monitored remotely, which would allow patients to continue to access healthcare professionals, even in a remote location (Mason, 2022). Despite that, however, other critics suggest that telemedicine may not always lead to positive patient outcomes across the board, particularly in areas where adequate internet or digital devices are simply not available (Mojdehbakhsh et al., 2021). Lack of access to the required technology in these cases may prevent patients from fully participating in telemedicine platforms leading to poor health outcomes (Ezeamii et al., 2024; Shorna et al., 2024). Additionally, not everyone is good at using the technology and the lower the digital literacy is, the cost for the patient who might not be able to navigate around these telemedicine systems is going to be the quality of care they receive as well as their satisfaction (Mason, 2022).



Research shows that access to telemedicine has been increasingly acknowledged as being a transformative force helping transform healthcare and has been positively linked to better patient outcomes. According to Ezeamii et al. (2024), telemedicine has revolutionised healthcare delivery by making it possible to reach out to more patients in remote and underserved areas as well as to speed up interventions. This improved accessibility facilitates early diagnosis and continues monitoring that are crucial for the management of chronic conditions and avert the complications (Ezeamii et al., 2024).

Furthermore, the application of big data analytics in remote patient monitoring, as described by Shorna, Sultana, and Hasan (2024) helps the clinicians to leverage the real time health information to design treatment strategies in an effective manner. The integration of technology beyond clinical support helps to create a patient centered approach, an important dimension of satisfaction in telemedicine, as Mason (2022) describes. However, some researchers have expressed its limitations of telemedicine, and they say that its benefits are at the risk of being overwhelmed by technological literacy barriers and inconsistent patient engagement (Mason, 2022).

It also was criticized as programs that patients with limited digital access could make little of, further widening the health disparities (Shorna et al., 2024). However, The work by Mojdehbakhsh et al. (2021) provides practical evidences: very rapid implementation of telemedicine services, particularly during the COVID 19 pandemic, produced significant improvement in patients scores and overall care quality. Therefore, the hypothesis proposed is as follows.

H1: Access to telemedicine services has a significant positive effect on improved patient outcomes.

In telemedicine settings, it is essential to take patient technological competence into account in order to realize better outcomes. Digital literacy enables patients to be in control of what they need to do in order to use telemedicine platforms and to actively participate in healthcare service. During the COVID-19 pandemic, they showed that competence to use telepharmacy technology will help increase medication management and facilitated patient adherence to treatment, increasing patient outcomes. At the same time, Nes et al. (2021) pointed out that, in parallel, this can contribute to improve patient care indirectly through better communication and service delivery, by strengthening the technological literacy that nursing education can incorporate into it.

On the contrary, there are contrasting views regarding the overall effect of technology competence on patient outcomes. According larva et al. (2022), healthcare to professionals' perceptions of digital health competence are not homogeneous, implying that different levels of competency may result in different patient experiences telemedicine. In addition, Terp et al. (2021) mentioned that older patients often lack or show low digital competence that can impede them to collaborate the telemedicine services, possibly degreasing the usage of the technology. These barriers notwithstanding, the evidence points to the fact that even patients with little technological skills can overcome these barriers and achieve better health outcomes with appropriate support and training. As a consequence, higher technological patient competence is associated, on average, with better clinical outcomes, and strategic interventions to bridge digital gaps and to ensure the equitable use of telemedicine are needed. Hence, the following hypothesis is proposed.

H2: Patient technological competence has a significant positive effect on improved patient outcomes.

Socioeconomic status is a key determinant in shaping healthcare experiences, and its influence is particularly pronounced in the context of telemedicine. Patients from lowincome communities often confront significant obstacles, such as limited access to advanced technology, unreliable internet connectivity, and lower digital literacy. These challenges can impede the effective use of telemedicine services, potentially limiting their ability to achieve improved health outcomes (Mahdi et al., 2022). Conversely, individuals from Low to Moderate-income groups generally have better access to digital resources, facilitating smoother interactions with telemedicine platforms. This enhanced accessibility enables them to benefit from timely consultations and continuous monitoring, which are critical for managing health conditions (Karim et al., 2024).

Furthermore, healthcare providers have observed that infrastructural shortcomings in low-income areas, including the lack of technical support and robust digital networks, contribute to disparities in service delivery (Kumar et al., 2022). As a result, the positive effects of telemedicine on patient outcomes are more pronounced in communities with higher incomes, where technology and support systems are more readily available. These contrasting experiences highlight the necessity of addressing socioeconomic barriers to ensure that telemedicine can equitably improve patient outcomes across all income levels. Hence, we postulate the following hypothesis:

H3: Effect of access to telemedicine services on improved patient outcomes vary across different income groups.



Figure 1 Conceptual Framework

Methodology:

A quantitative, cross sectional design was employed in the study to determine impact of access to telemedicine services and patient technological proficiency on the improved patient outcomes in the context of income level moderating effect. This design was provided given the growing telemedicine adoption and its importance in patient centered care (Mason, 2022) to enable a complete correlation of these variables. The investigation involved patients with chronic conditions like diabetes and hypertension that had already used the telemedicine services for more than three months. Using this approach, the participants had enough exposure to telemedicine to have a meaningful assessment of its effectiveness in improving health outcomes (Kędzierski et al., 2022).

Purposive sampling was used to select participants to cover a wide range in the income levels of participants, as income level is a large factor in the ability to access and utilize medical care (Hoque et al., 2021). Adults 18 years and older who meet diagnosis of chronic condition and have used the telemedicine services for at least three constituted inclusion months criteria. Excluded were patients who needed immediate in person care, who do not have access to telecommunication devices or internet, or who are not able to provide informed consent. The criteria included in this sample were such that the sample participants could reasonably engage with telemedicine, as has been the case with previous studies of digital health competence (Jarva et al., 2022).



The questionnaire used Likert scale to measure the access to telemedicine services and the technological competence of the patients as independent variables. Availability, ease of use, and frequency of telemedicine consultations were examined in terms of access since telemedicine has been shown to improve the quality of healthcare (Mojdehbakhsh et al., 2021). Proficiency in using telemedicine platforms was evaluated as patient technological competence, a concept that has been shown to be critical to healthcare interactions (Nes et al., 2021). Income level was categorized into three groups-low, moderate, and high-to examine its moderating role in patient outcomes, as socioeconomic status is a known determinant of healthcare disparities (Meng et al., 2024). For data analysis, multiple linear regression was employed in SPSS to examine the direct

Data Analysis and Results

relationships between access to telemedicine services, patient technological competence, and improved patient outcomes. This method was chosen for its ability to assess the independent effects of predictor variables on the outcome (Preaux et al., 2023). To test the effect of income level, Multi-Group Analysis (MGA) was conducted in SmartPLS-SEM. By dividing the sample into income-based groups, this approach allowed for a comparative analysis of how access to telemedicine and patient competence influenced outcomes across different income levels (Shaverdian et al., 2021). This method was deemed appropriate as it provided a robust analysis without requiring complex moderation models, aligning with recent studies on digital health equity (Shorna et al., 2024).

Table 1	Respondent Demo	graphic Profile (N = 20	00)		
	Category	Subcategory	Subcategory Frequency (n)		
	Gender	Male	146	73%	
		Female	54	27%	
	Age Group	18 – 30 years	120	60%	
		31 – 40 years	50	25%	
		41 - 50+ years, Excellence i 30 ucation & Research		15%	
	Income Level				
		Low	80	40%	
		Moderate	120	60%	
	Location	Karachi	120	60%	
		Hyderabad	50	25%	
		Sukkur	30	15%	

Table 1 presents the demographic profile of respondents (N = 200), highlighting key variables relevant to the study. The majority are male (73%) and aged 18–30 years (60%), indicating a younger population. Most

across the 15 items. This suggests that the

participants belong to the moderate-income group (60%) and reside in Karachi (60%), reflecting urban-centered telemedicine accessibility trends.

Table 2 Kenability Statistics								
Cronbach's Alpha	Cronbach's Alpha Base	N of Items						
.935	.9	15						
Table 2 displays the relia	bility statistics for the	survey instrument effe	ectively captures					
study's measurement s	cale, assessed using	telemedicine access, patien	t competence, and					
SPSS. The high Cronba	ach's Alpha value of	health outcomes, ensuring reliable data for						
0.935 indicates excellent	t internal consistency	analysis.						

Table 2 Deliability Statistics

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Table 3 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of	Change Statistics				
				the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.736ª	.542	.538	.51473	.542	116.645	2	197	<.001
a.	Predic	ctors: (C	onstant), Comp	posite_Patient_Technological_Competence,					

Composite_Access_Telemedicine_Service

Table 3 presents the model summary for the multiple linear regression analysis. The Rvalue of 0.736 indicates a strong relationship between the predictors and patient outcomes.

The R-Square value of 0.542 suggests that 54.2% of the variance in patient outcomes is explained by access to telemedicine and technological competence.

Table 4 ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.			
1	Regression	61.809	2	30.904	116.645	<.001 ^b			
	Residual	52.194	197	.265					
	Total	114.003	199						
a Depen	a Dependent Variable: Composite Improved Patient Outcome								

Predictors: Composite_Patient_Technological_Competence, b. (Constant), Composite_Access_Telemedicine_Service

Table 4 presents the ANOVA results for the regression model. The F-value of 116.645 and a significance level of <0.001 indicate that the model is statistically significant. This confirms that access to telemedicine and

patient technological competence collectively contribute to explaining variations in improved patient outcomes in the study population.

Table 5 Coefficients

Table 5 Coefficients								
Predictor Variables	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig. (p-value)	Tolerance	VIF	
(Constant)	0.913	0.182	relience in Education & Research	5.015	<0.001			
Access to Telemedicine Services	0.280	0.068	0.281	4.100	<0.001	0.496	2.015	
Patient Technological Competence	0.468	0.063	0.510	7.455	<0.001	0.496	2.015	

a. Dependent Variable: Composite_Improved_Patient_Outcome Table 5 presents the results of multiple linear regression analysis, used to test Hypotheses H1 and H2. The findings reveal that access to telemedicine services ($\beta = 0.281$, p < 0.001) and patient technological competence (β = 0.510, p < 0.001) significantly predict improved patient outcomes. This confirms

that both factors positively influence healthcare effectiveness, supporting both hypotheses. The Variance Inflation Factor (VIF) values indicate no multicollinearity concerns. The test was conducted using SPSS to determine the strength and significance of these relationships, affirming that improved access and technological proficiency enhance patient outcomes in telemedicine settings.

Table 6 Multi Group Analysis (Role of Income Groups)

	Low Income Group			Moderate Income Group		
	Beta	T Statistics	P Value	Beta	T Statistics	P Value
Access to Telemedicine Services -> Improved Patient Outcome	0.689	5.464	0.000	0.877	26.562	0.000

Hypotheses H1 and H2 are tested using results of multiple linear regression analysis as presented in Table 5. It is found the patient quality outcomes (QoE) can be derived significantly by accessibility of telemedicine (β = 0.281, p < 0.001) and patient technological competence ($\beta = 0.510$, p < 0.001). Thus, both factors positively affect healthcare effectiveness, supporting both hypotheses. There are no multicollinearity concerns since the Variance Inflation Factor (VIF) values are reasonable. To determine the strength and significance of these relationships, the test was run in SPSS and confirmed that improved access and technological proficiency leads to better patient outcomes in telemedicine settings.

Discussion

This finding in turn shows that the impact of having access to telemedicine services on better patient outcomes depends on their income levels and is stronger in case of moderate income individuals. This also corresponds with the studies done by Mahdi et al. (2022) and Karim et al. (2024) validating their correlation with the distribution of health talk and how socioeconomic status affect healthcare access and digital engagement. Specifically, Mahdi et al. (2022) point out that the technological barriers for lower income people, for example, have unreliable internet connectivity and are not very digit literate can limit the beneficial effects of telemedicine services on patient outcomes. Kumar et al. (2022) agree that infrastructural inadequacies in the low income area aggravate these issues, making service delivery and patients experience varied.

Our findings, however, are contrary to Alabdali and Husain (2023), who showed a positive relationship between the telemedicine service quality and patient satisfaction, particularly in the settings with better technological access. Our study findings show significantly higher beta value $(\beta = 0.877)$ for the moderate income group, which indicates these individuals may have better ability to use and be informed about technology and health care, and may prefer to use the telemedicine platform better. This is in line with Meng et al. (2024) who found that responsiveness, reliability and empathy were the key factors that influence the patient satisfaction with telemedicine services. These findings also have implications for areas that need to fill the digital divide between higher and lower income communities. Filling technical literacy gaps and guaranteeing internet reliability would boost the usefulness of telemedicine services for underserved people. Additionally, as pointed out by Hoque et al. (2021), a framework such as SERVQUAL can aid in inadequacies, and discovering improve quality in telemedicine service delivery. healthcare policymakers and providers can help to achieve equitable telemedicine for all income group holistically, with better healthcare outcomes.

Conclusion and Future Directions

This study reinforces the significance of telemedicine services in improving patient outcomes, particularly by enhancing healthcare accessibility, engagement, and treatment adherence. Our findings validate the SERVQUAL model's applicability in telemedicine, highlighting that service quality dimensions such as reliability, responsiveness, and empathy play crucial roles in shaping satisfaction. Furthermore. patient technological competence emerged as a key determinant, as patients with higher digital literacy experienced greater benefits from telemedicine services. However, socioeconomic disparities continue to affect patient experiences, emphasizing the need for targeted interventions to bridge digital gaps. Overall, this study affirms that while telemedicine holds great potential, its effectiveness varies based on accessibility, competence, and income levels.



For healthcare administrators and policymakers, the findings underscore the importance of investing in digital health literacy programs to empower patients in using telemedicine platforms effectively. Hospitals and telehealth providers should technology integrate user-friendly with intuitive interfaces to accommodate patients with varying levels of digital competence. Additionally, healthcare organizations should prioritize infrastructure development in underserved communities, ensuring stable internet connectivity and adequate support services. From a strategic standpoint, service providers must enhance reliability and responsiveness, as these factors directly influence patient trust and long-term engagement with telemedicine services.

Future studies should explore the long-term impact of telemedicine adoption on chronic disease management and patient retention. Additionally, qualitative research could provide deeper insights into patient experiences, particularly among elderly or low-income populations. Examining the role of artificial intelligence and big data in optimizing telemedicine service quality is another promising avenue. Comparative studies across different healthcare systems could also reveal best practices for telemedicine implementation on a global scale. Addressing these areas will further strengthen the evidence base for integrating telemedicine into mainstream healthcare services effectively.

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