ORIGINAL ARTICLE

Impact of telemedicine service quality on patient satisfaction: an empirical study using Servqual model and expectation confirmation theory

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ABSTRACT

The COVID-19 pandemic has expedited the digital transformation of healthcare, facilitating the adoption of telemedicine as an innovative model for enhancing the quality of patient care. This study aimed to investigate the factors influencing patient satisfaction with telemedicine and provide practical guidance for improving service quality. Specifically, this study examined how service responsiveness, reliability, assurance, and empathy affect patient satisfaction while considering the role of expectation confirmation. This study employed quantitative research methods to examine telemedicine's effect on patient satisfaction, utilizing the SERVQUAL model and expectation-confirmation theory. A structured questionnaire using a seven-point Likert scale was developed to assess the dimensions of expectancy confirmation, responsiveness, reliability, assurance, and empathy. A random sample of 333 valid questionnaires was obtained through an online platform. Structural equation modeling (SEM) was employed to analyze the data; the findings indicated that all hypotheses were supported. Responsiveness significantly and positively influenced expectation confirmation, whereas expectation confirmation, responsiveness, reliability, assurance, and empathy significantly and positively affected patient satisfaction. The model exhibited strong explanatory power, indicating that these factors significantly influenced patient satisfaction with telemedicine. These findings provide valuable insights for healthcare providers to improve the quality of telemedicine services and patient satisfaction. These findings can guide healthcare organizations to develop more effective telemedicine platforms and training programs, contributing to the digital transformation of healthcare systems.

Keywords:
digital transformation; healthcare; hospital; patient satisfaction; telemedicine

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INTRODUCTION

The coronavirus disease (COVID-19) pandemic has expedited the digital transformation of healthcare worldwide, and its momentum continues to grow, with the global telemedicine market projected to reach $500 billion by 2030.[1,2] Thus, telemedicine has become an important model for delivering quality patient care.[3-5] Telemedicine enables remote treatment, allowing patients to access clinical care via technologies such as computers or smartphones, and eliminating the requirement for physical presence at the clinic. Telemedicine offers patients more flexibility in accessing healthcare services and minimizes the risk of infection.[6] Telemedicine effectively reduces patient rehospitalization rates and offers benefits by decreasing patients' financial and time-related costs. In the United States, it is frequently used in the treatment of various conditions, including radiology, psychiatry, and cardiology.[7] A significant percentage of patients in China have expressed their willingness to use telemedicine services, particularly for managing respiratory, skin, and musculoskeletal disorders.[8]

Telemedicine differs from traditional healthcare because it has limitations that may affect patient satisfaction. Primarily, it depends on the quality of the network and stability of the equipment, posing challenges for both patients and doctors. Issues related to equipment or network quality for either party can restrict its effectiveness. Remote areas are more likely to encounter this challenge.[9,10]

Moreover, there is a risk of online healthcare systems experiencing technical failures, and healthcare providers may lack engagement with the system. These factors could result in delayed responses from doctors, increased challenges in diagnosis, and ineffective communication, ultimately contributing to poor online healthcare outcomes and decreased patient satisfaction.[11] The absence of empathy may also result in diminished patient satisfaction.[12] Face-to-face interactions are more likely to express empathy; however, empathy can also be communicated effectively in online settings, contingent upon the healthcare provider's digital literacy and communication skills.[13]

However, research has revealed significant digital literacy (DL) disparities among physicians. Around 20-30% of healthcare professionals need to improve their DL, and this disparity is more pronounced in less developed regions, where studies have shown that only half of the healthcare professionals have adequate DL.[14,15]This IT anxiety can negatively affect performance expectations and productivity, hindering the effective adoption of telemedicine technology.[16]

In addition to the technical and communication challenges, telemedicine also faces ethical issues related to data security and patient privacy protection. For example, challenges such as weak password authentication and eavesdropping attacks can lead to unauthorized access and data leakage.[17]

Studies on patient satisfaction with telemedicine have yielded several important findings. Surveys conducted in urban outpatient settings have shown that the accessibility and responsiveness of telemedicine services are key factors influencing patient satisfaction in vulnerable populations, especially for patients facing barriers to accessing care.[18] In-depth studies of patient telemedicine experience have shown that effective communication and empathetic performance are core elements in improving patient satisfaction, emphasizing the importance of patient-centered care models in telemedicine practice.[19] In addition, a study on the quality assessment of telemedicine consultations proposed a comprehensive conceptual model that provides a new perspective on assessing service quality during patient-physician interactions.[20]

This study employed SERVQUAL[21] as a theoretical framework to examine the impact of telemedicine on patient satisfaction with a focus on responsiveness, reliability, assurance, and empathy. Additionally, the Expectation Confirmation Effect[22] was innovatively applied to develop patient-centered research, as patients anticipate prompt responses from doctors in online healthcare, influencing their expectations regarding the effectiveness of online medical treatments. To streamline the framework, we excluded tangibility, which is primarily assessed using offline methods.

METHODS

This study examined the impact of telemedicine service quality on patient satisfaction. Thus, we proposed a research framework that integrates the SERVQUAL model and the Expectation Confirmation Theory (ECT). Each of the four dimensions of the SERVQUAL model reflects different characteristics of telemedicine: responsiveness refers to the ability of doctors and systems to respond quickly to patients' needs; reliability is reflected in the accuracy and effectiveness of remote diagnosis and treatment; assurance focuses on the stability of the technological platform and the professionalism of the healthcare service; and empathy is shown in the caring and understanding that healthcare professionals express through online communication. ECT is mainly used to assess whether patients' expectations are met, particularly in terms of responsiveness, because patients in telemedicine are most likely to receive timely responses and feedback. Patient satisfaction increases when the actual service experience meets or exceeds expectations. Figure 1 illustrates the theoretical framework of the study.

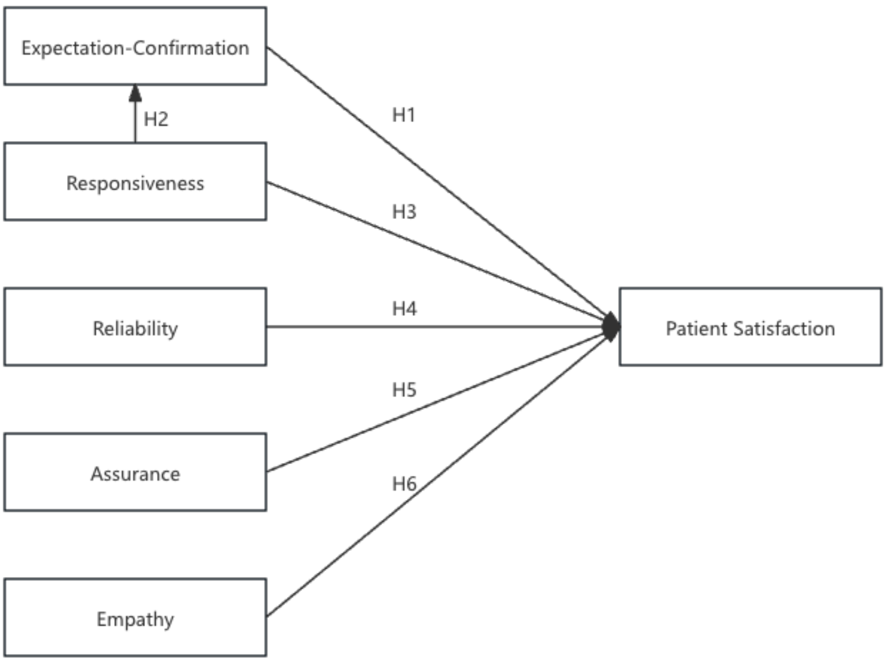

Figure 1. Research framework

Research instrument

Previous guidelines for the structural equation modeling (SEM) questionnaire design were consulted to identify measurements from earlier healthcare studies.[23-25] Research integrating ECT and SERQUAL in telemedicine is relatively limited. Consequently, the questionnaire for this study synthesizes existing telemedicine studies that have employed ECT or SERQUAL.[18,26-29] The questionnaire design process employed the Delphi method[30] and involved comprehensive discussions with experts in digital transformation and healthcare management to create a preliminary draft. Given the benefits of large-scale reliability and validity measures, we chose a seven-point Likert scale.[31,32] The Cronbach's alpha coefficients ranged from 0.795 to 0.894, indicating good reliability, The finalized questionnaire content, following extensive validation in both theoretical and practical contexts, is presented in Table 1.

Table 1. Question items

Constructs	Coding	Items
Expectation-Confirmation (EC)	EC1	My experience with telemedicine services was better than I initially expected.
d	EC2	Using telemedicine services yielded greater therapeutic advantages than I had first anticipated.
ad	EC3	Overall, telemedicine services met my initial expectations.
Responsivenes s (RP)	RP1	I can easily use the telemedicine system to communicate with the clinician.
	RP2	When there is a problem with the telemedicine system, the hospital can provide a quick and efficient solution.
	RP3	Through online technology, the doctor can easily provide medical services to me.
	RP4	When I communicate with the telemedicine service provider, they respond quickly.
Reliability (RL)	RL1	Telemedicine is an acceptable form of healthcare service.
	RL2	I believe that doctors can convey the information they want to express through telemedicine.
	RL3	I believe that telemedicine does not compromise the quality of healthcare.
Assurance (AS)	AS1	I can use digital platforms for telemedicine.
	AS2	I have good internet connectivity and equipment to conduct telemedicine.
	AS3	I have great confidence in the telemedicine service providers.
	AS4	Telemedicine offers a comprehensive disease management solution that helps doctors manage patients' conditions more effectively.
Empathy (EM)	EM1	The telemedicine service staff show concern for my questions or concerns.
	EM2	The explanations provided by the telemedicine service staff regarding my issues or conditions satisfy me.
	EM3	The telemedicine service staff agree to involve me in decisions related to my care.
	EM4	The friendliness and politeness of the telemedicine service staff make me feel satisfied.

Constructs	Coding	Items
	EM5	The telemedicine service staff actively encourage me to participate in decisions related to my care.
Patients' Satisfaction (PS)	PS1	I thought the telemedicine sessions with the doctor to be both relaxing and enjoyable.
	PS2	Overall, I am satisfied with this telemedicine system.
	PS3	I would use telemedicine services again.
	PS4	I am willing to recommend telemedicine services to others.
Basic information	Gender (select One answer choice) A. Male B. Female Age (select one answer choice): A. Under 18 years old B. 18-30 years old C. 31-40 years old D. 41-50 years old E. 51-60 years old F. Over 60 years old Frequency of using telemedicine (select one answer choice): A. Used only once B. Use once per month C. Use once per quarter D. Use once per year E. Never used	

Research design

This study used a combination of convenience sampling and snowball sampling to collect data from people who had used telemedicine services in the past year. Questionnaires were first distributed through clusters of healthcare-related WeChat groups, including hospital visit exchange groups, health consultation groups, and community service groups, to reach potential participants. Members of the clusters were also asked to help forward the questionnaire to other eligible respondents to expand sample coverage. The survey utilized a cross-sectional design, and respondents were informed of the study's purpose before participating; their participation was completely voluntary and anonymous. Considering the differences in the application of telemedicine services in different healthcare scenarios, the types of telemedicine services received by the respondents included a variety of forms, such as online consultation, teleconsultation, and health counseling, which helped to comprehensively assess the telemedicine services' quality. The data were analyzed using SEM. Descriptive statistics and reliability analysis were performed using SPSS 27.0, and path analysis and hypothesis testing were performed using Amos 26.0.

Data collection

The questionnaire was disseminated to WeChat Groups via the online platform WJX (https://www.wjx.cn/), resulting in the collection of 349 responses. After data screening, 16 questionnaires recorded as "Never used" were excluded from the analysis. A total of 333 valid questionnaires were retained for analysis. In the sample, 151 participants (45.35%) were male, and 182 participants (54.65%) were female. The age group statistics included 7 individuals (2.1%) under 18 years old, 51 individuals (15.32%) between 18–25 years, 81 (24.32%) between 26–30, 91 (27.33%) between 31–40, 63 (18.92%) between 41–50, 19 (5.71%) between 51–60, and 21 individuals (6.31%) above 60 years old. Concerning usage frequency, 87 people (26.13%) indicated that they used telemedicine only once, 97 (29.13%) reported monthly use, 119 (35.74%) used it quarterly, and 30 participants (9.01%) used it annually.

Data Analysis

Common method variance test

The question format was first streamlined to enhance comprehension. Second, we allocated questions with varying constructs across separate pages to mitigate respondent fatigue and enhance attention, thereby diminishing the potential for common method bias associated with the use of a uniform scale.[33-35]

We employed supplementary statistical techniques to evaluate potential common method bias, thereby enhancing data quality. We employed a one-way test technique[36] in conjunction with principal component analysis for validation purposes. The test results indicated that the eigenvalue for the item with the highest percentage of principal components was 7.55, representing only 29.05% of the total variance, significantly below the 50% threshold. The eigenvalues of the six factors exceeded 1, indicating that no single factor predominantly influenced the data. Thus, the findings suggest that the data were not significantly influenced by common method bias, and thereby provided a solid basis for subsequent analyses.

Reliability and validity tests

The credibility of the research results is directly linked to the quality of the questionnaire. Therefore, we performed thorough reliability and validity assessments of the instrument.[37] Three key metrics comprehensively evaluated the questionnaire: Cronbach's alpha, composite reliability (CR), and convergent validity. Table 2.2 provides the results. The Cronbach's alpha for most variables was greater than 0.8, indicating excellent internal consistency. The coefficient of the EM variable was notably high at 0.894, nearing a 0.9 standard of excellence. The RL variable exhibits a coefficient of 0.795, which remains within an acceptable range although below 0.8.[38,39] The data indicate high level of stability in the questionnaire's measurement of the target concept. Reliability was substantiated by the CR values of all variables, which exceeded the acceptable threshold of 0.7 for composite reliability. The test indicated that the average variance extracted (AVE) values, which must exceed 0.5 for each variable, exceeded the threshold, thereby confirming the convergent validity of the questionnaire.[40, 41]

Table 2. Convergent validity test results

			Unstd.	S.E.	z-value	P	Std.	SMC	CR	AVE	Cronbach's alpha
Q1	<---	EC	1.031	0.075	13.679	<.001	0.816	0.666			
Q2	<---	EC	1.017	0.076	13.427	<.001	0.784	0.615	0.836	0.630	0.836
Q3	<---	EC	1.000				0.781	0.610			
Q4	<---	RP	1.002	0.070	14.381	<.001	0.768	0.590			
Q5	<---	RP	1.019	0.069	14.711	<.001	0.784	0.615	0.862	0.610	0.864
Q6	<---	RP	1.016	0.070	14.497	<.001	0.774	0.599			
Q7	<---	RP	1.000				0.797	0.635			
Q8	<---	RL	1.094	0.095	11.527	<.001	0.776	0.602			
Q9	<---	RL	1.014	0.088	11.467	<.001	0.766	0.587	0.796	0.566	0.795
Q10	<---	RL	1.000				0.713	0.508			
Q11	<---	AS	0.977	0.070	13.918	<.001	0.780	0.608			
Q12	<---	AS	0.917	0.069	13.334	<.001	0.747	0.558	0.854	0.593	0.853
Q13	<---	AS	0.995	0.072	13.827	<.001	0.775	0.601			
Q14	<---	AS	1.000				0.778	0.605			
Q15	<---	EM	1.044	0.069	15.232	<.001	0.786	0.618	0.894	0.628	0.894
Q16	<---	EM	0.982	0.063	15.498	<.001	0.797	0.635			

			Unstd.	S.E.	z-value	P	Std.	SMC	CR	AVE	Cronbach's alpha
Q17	<---	EM	1.015	0.068	14.941	<.001	0.773	0.598			
Q18	<---	EM	1.034	0.065	15.894	<.001	0.814	0.663			
Q19	<---	EM	1.000				0.793	0.629			
Q20	<---	PS	1.000				0.730	0.533			
Q21	<---	PS	1.008	0.082	12.345	<.001	0.747	0.558	0.832	0.554	0.836
Q22	<---	PS	1.012	0.084	12.090	<.001	0.730	0.533			
Q23	<---	PS	1.042	0.082	12.645	<.001	0.769	0.591			

Note: Unstd. = unstandardized coefficient; S.E. = standard error; z-value = critical ratio; P = significance level; Std. = standardized coefficient; SMC = squared multiple correlation; CR = composite reliability; AVE = average variance extracted; *p < .05, **p < .01, ***p < .001.

Discriminant validity test

To ensure the accuracy and reliability of the study, the questionnaire was tested for discriminant validity. The square root of the AVE for each construct was compared with the correlation coefficients between that construct and other constructs[42]. Good discriminant validity was indicated when the AVE square root exceeded all correlation coefficients. Table 3 presents the results, with bold values on the diagonal indicating the square root of the AVE. Each bold value exceeds the others within its respective column. This result indicates significant differences among the constructs, highlighting the uniqueness of each and validating the questionnaire.

Table 3. Convergent validity and distinguished validity

Convergent validity		Discriminant validity					
	AVE	RL	RP	PS	EM	AS	EC
RL	0.566	**0.752**					
RP	0.610	0.467	**0.781**				
PS	0.554	0.489	0.496	**0.744**			
EM	0.628	0.366	0.402	0.437	**0.792**		
AS	0.593	0.386	0.348	0.514	0.333	**0.770**	
EC	0.630	0.411	0.384	0.442	0.411	0.409	**0.794**

Note: The bold numbers on the diagonal are the square root of AVE, and the lower triangle is the facet Pearson correlation coefficient.

Structural model validation

Path analysis using Amos 26.0 showed support for all six hypotheses. The analysis revealed a significant positive effect of responsiveness on expectation confirmation (β = 0.419, p < 0.001), explaining 17.6% of the variance. This suggests that in a telemedicine setting, patients expect a timely response, an expectation met when healthcare providers can respond quickly to patient needs, which in turn enhances patient satisfaction through expectation confirmation (β = 0.129, p < 0.05).

Analysis of other influences on patient satisfaction showed that assurance had the strongest effect (β = 0.277, p < 0.001), suggesting that the technical stability of the telemedicine platform and the professionalism of the healthcare service were the primary factors influencing patient satisfaction. RP had both a direct (β = 0.208, $p < 0.01$) and indirect effect through expectation confirmation, reaffirming the importance of timely response. The effects of RL (β = 0.186, $p < 0.01$) and EC (β = 0.148, $p < 0.01$) suggest that an accurate diagnostic and treatment process and emotional support from healthcare professionals are also important factors in enhancing patient satisfaction. Together, these variables explained 43.6% of the variance in patient satisfaction, indicating that the service quality dimensions selected in this study were effective in explaining patient satisfaction in telemedicine settings.

Table 4. Structural model results

			Unstd.	S.E.	C.R.	P	Std.(β)	R^2
RP	--->	EC	0.428	0.067	6.411	<.001	0.419	0.176
EC	--->	PS	0.123	0.058	2.098	0.036	0.129	
RP	--->	PS	0.202	0.073	2.763	0.006	0.208	
RL	--->	PS	0.206	0.078	2.626	0.009	0.186	0.436
AS	--->	PS	0.269	0.063	4.283	<.001	0.277	
EM	--->	PS	0.143	0.06	2.4	0.016	0.148	

Note: Unstd. = unstandardized coefficient; S.E. = standard error; C.R. = critical ratio; P = significance level; Std.(β) = standardized beta coefficient; R^2 = explanatory power; *p < .05, **p < .01, ***p < .001.

DISCUSSION

The results indicate a significant effect of RP on EC, with a standardized coefficient (Std. β = 0.419, $p < 0.001$). Patients using telemedicine typically expect more efficient and streamlined visits. Technical issues, including inadequate network quality or faulty equipment, can significantly impair the patient experience. The quality of equipment and networks utilized in hospitals is crucial for addressing needs and improving patients' overall experience. Effectively functioning remote software in hospitals requires the presence of reliable computers and network facilities.[43] The patient's experience with telemedicine is critical. While this study covers a wide range of telemedicine service types, from online consultations to teleconsultations, the findings consistently show that, regardless of the service type, online healthcare platforms should be easy to use, accessible, and adaptable.[44, 45] Therefore, we recommend implementing a simplified, user-friendly online healthcare software design to minimize system failures and vulnerabilities, and to effectively improve responsiveness. Future research should further explore the specific differences in responsiveness requirements across different types of telemedicine services.[46] Timely online responses from physicians can also enhance patients' satisfaction, thereby increasing the probability of continued treatment.[47] Digital literacy among physicians is essential to enhance remote telemedicine practices. Insufficient training may hinder the ability of physicians, particularly those who are older and unacquainted with technology, to communicate effectively with patients online.[48, 49] Patients' digital literacy similarly influences telemedicine RP.[50]

Data analysis indicated a positive effect of expectation confirmation on patient satisfaction, with a standardized coefficient of 0.129 ($p < 0.05$). Thus, we conclude that the confirmation of patients' expectations significantly influences their satisfaction levels. Patients anticipate that online healthcare services will meet their initial treatment expectations and may cease use if these expectations are unfulfilled. Conversely, they are more inclined to persist in using telemedicine if their service expectations are met.[51] Consequently, hospitals should refrain from excessively promoting telemedicine services because inflated patient expectations can result in cognitive dissonance. When actual experiences do not align with patients' expectations, dissatisfaction may result. Excessive customer expectations are not inherently advantageous and may adversely affect the organization.[52]

The data analysis indicated that the responsiveness of healthcare providers significantly influenced patient satisfaction with telemedicine (standardized coefficient (Std. $\beta = 0.208$, $p < 0.005$)). Responsiveness serves as a critical performance indicator, fostering a sense of understanding and respect among patients.[53] This is fundamental to delivering patient-centered services. Telehealthcare providers must enhance and innovate their responsiveness to improve patient experience and satisfaction through technology advancements and healthcare professionals' training.[54]

Reinforcement learning significantly influenced patient satisfaction with telemedicine, with a standardized coefficient of 0.186 and a *p*-value of less than 0.005. Patients may express heightened concerns regarding the reliability of services due to distance and the apprehension that treatment could be compromised in remote settings, leading to inadequate care. Research indicates that the reliability of telemedicine for diagnosing specific conditions, including shoulder aches and pain is questionable.[55] It is advisable for telemedicine service providers to select diagnostic methods that remain unaffected by distance. In addition, hospitals should guide patients to pursue offline care for conditions that are better suited for face-to-face diagnosis.[56] To enhance reliability, telemedicine providers should focus on improving safety and effectiveness. Simplifying and standardizing processes are effective strategies to achieve these goals, as streamlining reduces the likelihood of errors, allowing providers to concentrate on delivering care. Hiring reliable and specialized technical teams is crucial for enhancing system reliability. This includes the integration of the Internet of Things, software-defined networking, and network function virtualization technologies to address resource constraints and routing issues, and the utilization of horizontal and vertical backup mechanisms to improve service availability and reliability.[57]

AS significantly influenced patient satisfaction, with a standardized coefficient of 0.277 and a p-value of less than 0.001. Effective assurance fosters a sense of safety in telemedicine, bolsters trust, alleviates anxiety, and significantly contributes to patient satisfaction.[58] The usability of the telemedicine platform significantly contributes to establishing a stable and high-quality foundation for doctor-patient interactions. To overcome communication barriers telemedicine platforms should include features such as high-quality videoconferencing, real-time translation capabilities, and interactive tools that allow providers to better explain medical queries.[59,60] These technological capabilities can help compensate for the lack of face-to-face contact by enhancing empathy through clear visual and audio interactions. Consequently, telemedicine providers must prioritize patient-centered approaches when selecting systems and software to enhance service accessibility, thereby improving patient trust and satisfaction.[19,20]

EM significantly influenced patient satisfaction, with a standardized coefficient of 0.148 and a p-value of < 0.005. Empathy constitutes an essential element of telehealth care delivery and is vital for the management of patient-provider interactions. The empathy exhibited by providers enhances outcomes by increasing patients' willingness to accept and adhere to medical advice, thereby improving outcomes and satisfaction.[61,62] Remote communication, may lead to less effective emotional communication compared to offline interactions, potentially impacting trust and satisfaction.[63] Thus telemedicine providers must cultivate effective communication skills to ensure that empathy is effectively conveyed in virtual environments.[64] To overcome these emotional communication limitations, healthcare providers can adopt several strategies: utilize richer forms of nonverbal communication (e.g., appropriate facial expressions and gestures), express concern by asking questions and actively listening, and set aside time for emotional connection during each remote consultation.[65,66] Simultaneously, specialized online communication skills training for healthcare workers is necessary.[67] The expression of empathy has dual implications: it can enhance patient satisfaction, but may also contribute to healthcare provider burnout if not adequately managed.[68]

Therefore, healthcare providers must implement patient-centered strategies aimed at improving overall healthcare performance to enhance patient satisfaction. This presents numerous challenges potentially arising from distance-related barriers, including delays, miscommunication, insufficient emotional connections, and patient expectations of prompt responses. Therapy teams must collaborate with technology teams to develop an efficient online healthcare delivery platform that ensures that patients receive high-quality, accessible, and reliable healthcare services.

In addition to service quality, telemedicine faces important ethical challenges with respect to patient privacy and data security.[69] Telemedicine platforms must establish strict data encryption mechanisms and implement strong password authentication to prevent unauthorized access and information leakage.[70] Healthcare organizations should develop comprehensive patient privacy protection policies to ensure that all telemedicine interactions comply with medical data protection norms.[71]

This study contributes theoretically by applying the SERVQUAL model to assess telemedicine patient satisfaction and combining the EC effect to highlight patients' expectations for prompt responses. This combination represents a novel approach to the empirical investigation of patient satisfaction in telemedicine. This study comprehensively explored the factors influencing satisfaction with patient-centered services, offering novel research methods and perspectives within healthcare. This theoretical framework can also be applied to other research domains centered on the user experience.

The results have several practical implications for healthcare practitioners and policymakers. First, healthcare organizations should prioritize the development of stable and professional telemedicine platforms because assurance has the strongest impact on patient satisfaction. This requires investment in technical infrastructure and medical staff training. Second, the dual effect of responsiveness (direct and indirect impacts confirmed through expectations) suggests that it is critical to establish clear response time standards and implement efficient online consultation processes. Healthcare providers should develop norms to ensure timely responses, while effectively managing patient expectations. Third, providers should not overlook the importance of offering emotional support in online interactions while maintaining the quality of professional services. Training programs should focus on helping healthcare professionals develop the skills to express empathy in virtual environments.

For policymakers, the findings suggest the need for comprehensive quality standards for telemedicine services. These include technical specification requirements, response time standards, healthcare service quality indicators, and doctor-patient communication norms. Simultaneously, policymakers should consider establishing a telemedicine service assessment system that incorporates service quality dimensions into the assessment indicators to promote the continuous improvement of telemedicine service quality.

However, this study has several limitations. The ability to capture dynamic changes in patient satisfaction over time was limited by the cross-sectional design. A longitudinal study design would enhance our understanding of long-term trends in the quality of medical services and patient satisfaction. In addition, demographic variables (e.g., age and educational level) as potential moderators were not included, which may significantly influence patients' perceptions of and satisfaction with telemedicine. For example, age may influence patients' acceptance of technology, thereby moderating the effect of assurance on satisfaction, whereas education level may influence patients' expectations of healthcare services.[72,73] Future research could explore how these demographic characteristics moderate the relationship between service quality dimensions and patient satisfaction. This study employed a comprehensive definition of telemedicine services without differentiating the various types of telemedicine. Diverse diseases and treatments require various telemedicine models that can influence patient experience and satisfaction. Finally, as this study collected data through the WeChat network in China during the post-epidemic period, the generalizability of the findings may be limited. Quantitative methods validated the theoretical model, which can be combined with qualitative studies in the future to delve into patients' needs and telemedicine experiences. Future studies should address these limitations to yield more precise and targeted insights.

CONCLUSION

Telemedicine differs from traditional healthcare because of its distinct characteristics that healthcare providers must consider. Telemedicine providers must ensure treatment effectiveness while maintaining reliability, prompt responses, assurance, and empathy, all of which significantly influence the patient's experience. Consequently, doctors must be trained in DL and online communication skills while hospitals must supply high-quality networks and equipment Telemedicine providers must consider patients' high expectations for prompt responses and effectively manage these because elevated expectations may lead to decreased satisfaction.

AUTHOR CONTRIBUTIONS

Meng Ching-Lin: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. Priya A/P Sukirthanandan: Supervision, Data curation, Investigation, Validation, Project administration.

ETHICAL CONSIDERATION

Ethical approval was obtained from the University of Cyberjaya Research Ethics Review Committee (CREC) with the reference number UOC/CREC/ER/703 on September 10, 2024.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Cheng TC, Sylvia S, Yip W. Innovative approaches of measuring care quality in China's market for telemedicine. Lancet Reg Health West Pac. 2024;46:100932.
2. Foo D, Spanos S, Dammery G, Ellis LA, Willcock SM, Braithwaite J. The rise of direct-to-consumer telemedicine services in Australia: implications for primary care and future research. Med J Aust. 2023;219(5):230-2.
3. Maines M, Palmisano P, Del Greco M, Melissano D, De Bonis S, Baccillieri S, et al. Impact of COVID-19 Pandemic on Remote Monitoring of Cardiac Implantable Electronic Devices in Italy: Results of a Survey Promoted by AIAC. J Clin Med. 2021;10(18):4086.
4. Zhang YF, Qiu Y, He JS, Tan JY, Li XZ, Zhu LR, et al. Impact of COVID-19 outbreak on the care of patients with inflammatory bowel disease: a comparison before and after the outbreak in South China. J Gastroenterol Hepatol. 2021;36(3): 700-9.
5. Jose AP, Kaushik A, Tange H, van der Weijden T, Pandey N, Sharma A, et al. Redesigning telemedicine: preliminary findings from an innovative assisted telemedicine healthcare model. BMC Prim Care. 2024;25(1):380.
6. Lucas JW, Villarroel MA. Telemedicine use among adults: United States, 2021. Natl Health Stat Rep. 2022;(432):1-8.
7. Hyder MA, Razzak J. Telemedicine in the United States: An Introduction for Students and Residents. J Med Internet Res. 2020;22(11):e20839.
8. Lin Y, Xu X, Liu Y, Alias H, Hu Z, Wong LP. Perception and Acceptance of Telemedicine Use in Health Care Among the General Public in China: Web-Based Cross-Sectional Survey. J Med Internet Res. 2024;26:e53497.
9. Yasmine M, Nessib DB, Ferjani H, Triki W, Maatallah K, Kaffel D, et al. The usefulness of telemedicine in rheumatology: points of view of practitioners and patients. Ann Rheum Dis. 2022;81(Suppl 1):1780-1.
10. Drake C, Zhang Y, Chaiyachati KH, Polsky D. The limitations of poor broadband internet access for telemedicine use in rural America: an observational study. Ann Intern Med. 2019;171(5):382-4.
11. Harst L, Timpel P, Otto L, Richter P, Wollschlaeger B, Winkler K, et al. Identifying barriers in telemedicine-supported integrated care research: scoping reviews and qualitative content analysis. J Public Health (Berl). 2020;28(5):583-94.
12. Rawal S. Physician empathy in patient empowerment and patient empowerment in physician empathy. Med Educ. 2023;57(8):694-6.
13. Agosta L. Empathy: A bridge across the digital divide. Psychoanal Rev. 2022;109(4):439-59.
14. Kuek A, Hakkennes S. Healthcare staff digital literacy levels and their attitudes towards information systems. Health Inform J. 2019;26(1):592-612.
15. Tegegne MD, Tilahun B, Mamuye A, Kerie H, Nurhussien F, Zemen E, et al. Digital literacy level and associated factors among health professionals in a referral and teaching hospital. Front Public Health. 2023;11:1130894.
16. Devaraj E, Satheesha TY, Yadav SPS, Kaviti RVP. Stress Management in an IT Professional Crisis. In: Rouco JC,

Figueiredo PCN, editors. Business Continuity Management and Resilience: Theories, Models, and Processes. Hershey (PA): IGI Global; 2024. p. 128-61.
17. Wang N, Zhang J, Huang J, Ou W, Han W, Zhang Q. Telemedicine data secure sharing scheme based on heterogeneous federated learning. Cybersecurity. 2024;7(1):56.
18. Kee D, Verma H, Tepper DL, Hasegawa D, Burger AP, Weissman MA. Patient Satisfaction With Telemedicine Among Vulnerable Populations in an Urban Ambulatory Setting. Mayo Clin Proc Digit Health. 2024;2(1):8-17.
19. Mason AN. The Most Important Telemedicine Patient Satisfaction Dimension: Patient-Centered Care. Telemed J E Health. 2022;28(8):1206-14.
20. Preaux J, Casadesús M, Bernardo M. A Conceptual Model to Evaluate Service Quality of Direct-to-Consumer Telemedicine Consultation from Patient Perspective. Telemed J E Health. 2023;29(2):156-71.
21. Parasuraman AP, Zeithaml V, Berry L. A Conceptual Model of Service Quality and its Implication for Future Research (SERVQUAL). J Mark. 1985;49(4):41-50.
22. Oliver RL. A cognitive model of the antecedents and consequences of satisfaction decisions. J Mark Res. 1980;17(4):460-9.
23. Park E. User acceptance of smart wearable devices: An expectation-confirmation model approach. Telemat Inform. 2020;47:101318.
24. Wang C, Dai J, Zhu K, Yu T, Gu X. Understanding the continuance intention of college students toward new E-learning spaces based on an integrated model of the TAM and TTF. Int J Hum Comput Interact. 2023; 39(14):2134-47.
25. Rahi S, Gillie M, Abd Ghani M. Designing survey research: recommendation for questionnaire development, calculating sample size and selecting research paradigms. In: Economic and Social Development: Book of Proceedings; 2019. p. 1157-69.
26. Blount E, Davey MG, Joyce WP. Patient reported satisfaction levels with the use of telemedicine for general surgery-A systematic review of randomized control trials. Surg Pract Sci. 2023;12:100152.
27. Sengupta A, Sarkar S, Bhattacherjee A. The relationship between telemedicine tools and physician satisfaction, quality of care, and patient visits during the COVID-19 pandemic. Int J Med Inform. 2024;190:105541.
28. Bovonratwet P, Song J, LaValva SM, Chen AZ, Ondeck NT, Blevins JL, et al. Telemedicine in Arthroplasty Patients: Which Factors Are Associated With High Satisfaction? Arthroplasty Today. 2024;25:101285.
29. Olivos M, García V, De La Torre L. Evaluation of user satisfaction in parents or caregivers of pediatric patients with colorectal pathology in the use of telemedicine. J Pediatr Surg Open. 2023;4:100060.
30. Batool SH, Rehman AU, Sulehri I. The current situation of information literacy education and curriculum design in Pakistan: a discovery using Delphi method. Libr Hi Tech. 2022;40(6):1705-20.
31. Lang FR, John D, Lüdtke O, Schupp J, Wagner GG. Short assessment of the Big Five: robust across survey methods except telephone interviewing. Behav Res Methods. 2011;43(2):548-67.
32. McDowell I. Measuring health: a guide to rating scales and questionnaires. 3rd ed. New York: Oxford University

Press; 2006.
33. Williams LJ, McGonagle AK. Four research designs and a comprehensive analysis strategy for investigating common method variance with self-report measures using latent variables. J Bus Psychol. 2016;31(3):339-59.
34. Shiau W-L, Sarstedt M, Hair JF. Internet research using partial least squares structural equation modeling (PLS-SEM). Internet Res. 2019;29(3): 398-406.
35. Cham TH, Cheng BL, Low MP, Cheok JBC. Brand image as the competitive edge for hospitals in medical tourism. Eur Bus Rev. 2020;33(1):31-59.
36. Hair Jr JF, Sarstedt M, Hopkins L, Kuppelwieser VG. Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. Eur Bus Rev. 2014;26(2): 106-21.
37. Roberts P, Priest H. Reliability and validity in research. Nurs Stand. 2006;20(44):41-6.
38. Christmann A, Van Aelst S. Robust estimation of Cronbach's alpha. J Multivar Anal. 2006;97(7):1660-74.
39. Liu Y, Wu AD, Zumbo BD. The impact of outliers on Cronbach's coefficient alpha estimate of reliability: Ordinal/rating scale item responses. Educ Psychol Meas. 2010; 70(1):5-21.
40. Wolter KM. An investigation of some estimators of variance for systematic sampling. J Am Stat Assoc. 1984;79(388):781-90.
41. Cheung GW, Cooper-Thomas HD, Lau RS, Wang LC. Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. Asia Pac J Manag. 2024;41(2):745-83.
42. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. J Mark Res. 1981; 18(1):39-50
43. Ftouni R, AlJardali B, Hamdanieh M, Ftouni L, Salem N. Challenges of telemedicine during the COVID-19 pandemic: a systematic review. BMC Med Inform Decis Mak. 2022; 22(1):207.
44. Ramírez-Saltos D, Acosta-Vargas P, Acosta-Vargas G, Santórum M, Carrion-Toro M, Ayala-Chauvin M, et al. Enhancing Sustainability through Accessible Health Platforms: A Scoping Review. Sustainability. 2023; 15(22):15916.
45. Herranz C, Martín-Moreno Banegas L, Dana Muzzio F, Siso-Almirall A, Roca J, Cano I. A Practice-Proven Adaptive Case Management Approach for Innovative Health Care Services (Health Circuit): Cluster Randomized Clinical Pilot and Descriptive Observational Study. J Med Internet Res. 2023;25:e47672.
46. Hort M, Kechagia M, Sarro F, Harman M. A survey of performance optimization for mobile applications. IEEE Trans Softw Eng. 2021;48(8): 2879-904.
47. Effendi DE, Handayani S, Nugroho AP, Ardani I, Fitrianti Y, Karlina K, et al. The Significance of Physician-Patient Communication on Telemedicine Patients' Health Outcomes: Evidence from Indonesia. Health Commun. 2024;39(10):1932-41.
48. Oudbier SJ, Souget-Ruff SP, Chen BS, Ziesemer KA, Meij HJ, Smets EM. Implementation barriers and facilitators of remote monitoring, remote consultation and digital care platforms through the eyes of healthcare professionals: a review of reviews. BMJ Open. 2024;14(6): e075833.
49. Oh SS, Kim K-A, Kim M, Oh J, Chu SH, Choi J. Measurement of digital literacy among older adults: systematic review. J Med Internet Res.

2021;23(2):e26145.
50. Ali D, Gillie M, Carstarphen KJ. Bridging the digital divide for vulnerable patient telehealth. Innov Aging. 2020;4(Suppl 1):928.
51. Kumar KA, Natarajan S. An extension of the Expectation Confirmation Model (ECM) to study continuance behavior in using e-Health services. Innov Mark. 2020;16(2):15-26.
52. Hamza V, Zakkariya K. A study on the dimensions of customer expectations and their relationship with cognitive dissonance. Int J Manag Stud. 2013; 3(2):47-54.
53. Askari R, Rafiei S, Montazerolfaraj R, Sepaseh F, Dehghani Tafti A, Irany Nasab M. Evaluation of Non-Medical Services' Responsiveness Using a National Model: Patients' Viewpoint. Biotechnol Health Sci. 2017;4(1):25-9.
54. Sharma D, Taggar R, Bindra S, Dhir S. A systematic review of responsiveness to develop future research agenda: a TCCM and bibliometric analysis. Benchmark Int J. 2020;27(9):2649-77.
55. Wang G, Fiedler AK, Warth RJ, Bailey L, Shupe PG, Gregory JM. Reliability and accuracy of telemedicine-based shoulder examinations. J Shoulder Elbow Surg. 2022;31(8):e369-75.
56. Toscano S, Patti F, Chisari CG, Arena S, Finocchiaro C, Schillaci CE, et al. Reliability of televisits for patients with mild relapsing-remitting multiple sclerosis in the COVID-19 era. Neurol Sci. 2022;43(4):2253-61.
57. Pham C, Nguyen KK, Cheriet M, Shabah A. Joint Horizontal and Vertical Backup for Highly Reliable Telemedicine Services. In: IEEE International Conference on Communications (ICC); 2023 May 28-Jun 1; Rome, Italy. IEEE; 2023. p. 2451-6.
58. Malathi A, Jasim KM. Validating the relationship between service quality, patient sensitivity and experience towards medical applications using SERVQUAL. Int J Med Inform. 2022;168:104883.
59. Guttikonda J, Sanchit A, Krishnamoorthy A, Chaudhary K, Likitha B, Prabakaran N. No Barrier: Breaking Language Barriers With NMT and Digital Twin Synergies. In: Ponnusamy S, Assaf M, Antari J, Singh S, Kalyanaraman S, editors. Digital Twin Technology and AI Implementations in Future-Focused Businesses. Hershey (PA): IGI Global; 2024. p. 195-205.
60. Meuter RFI, Gallois C, Segalowitz NS, Ryder AG, Hocking J. Overcoming language barriers in healthcare: A protocol for investigating safe and effective communication when patients or clinicians use a second language. BMC Health Serv Res. 2015;15(1):371.
61. Broadbridge E, Greene K, Venetis MK, Lee LE, Banerjee SC, Buckley de Meritens A, et al. The Influence of Perceived Provider Empathic Communication on Disclosure Decision-Making. Health Commun. 2024;39(9):1807-24.
62. Rey Velasco E, Demjén Z, Skinner TC. Digital empathy in behaviour change interventions: A survey study on health coach responses to patient cues. Digit Health. 2024;10:205520 76231225889.
63. Parkinson B, Lea M. Video-linking emotions. In: Kappas A, Krämer NC, editors. Face-to-Face Communication over the Internet: Emotions in a Web of Culture, Language, and Technology. Cambridge: Cambridge University Press; 2011. p. 100-26.
64. Cadet F, Sainfort F. Service quality in health care: empathy as a double-edged sword in the physician-patient relationship. Int J Pharm Health Mark.

2023;17(1):115-31.
65. Kim HY, Ali G, Hwang JI. Enhancing doctor-patient communication in surgical explanations: Designing effective facial expressions and gestures for animated physician characters. Comput Animat Virtual Worlds. 2024;35(3):e2236.
66. Gleeson HB, Kalsi AS. Remote clinical consultations in restorative dentistry-A survey. J Dent. 2022; 117:103914.
67. Power E, Attard MC, Lanyon LE, Togher L. Efficacy of online communication partner training package for student healthcare professionals. Int J Lang Commun Disord. 2024;59(1):304-26.
68. Kalms E. Is the Empathy and Clarity Rating Scale a way to assess empathy in realistic clinical encounters? Med Educ Online. 2019;24(1):1680101.
69. Maeckelberghe E, Zdunek K, Marceglia S, Farsides B, Rigby M. The ethical challenges of personalized digital health. Front Med. 2023;10: 1123863.
70. Dey J, Bhowmik A, Karforma S. Neural perceptron & strict lossless secret sharing oriented cryptographic science: fostering patients' security in the "new normal" COVID-19 E-Health. Multimed Tools Appl. 2022;81(13):17747-78.
71. Tazi F, Dykstra J, Rajivan P, Chalil Madathil K, Hughart J, McElligott J, et al. Improving privacy and security of telehealth. Commun ACM. 2024;67(9):27-30.
72. Yeh T-F, Chang Y-C, Yang S-Y, Yang C-C. Effect of Successful Aging on Technology Acceptance: The Moderating Role of Selection, Optimization, and Compensation Strategies. Soc Sci Comput Rev. 2024;42(2):324-41.
73. Rademakers J, Delnoij D, Nijman J, de Boer D. Educational inequalities in patient-centred care: patients' preferences and experiences. BMC Health Serv Res. 2012;12(1):261.