

Construction of a service quality evaluation index system for “Internet+nursing care” for disabled elderly based on the SPO model

Xiaoqin Zhang¹, Li Tang², Lingna Yu², Ting Jiang³, Yingwen Li⁴, Yun Tong² (✉)

¹Department of Joint Orthopedics II, Guangdong Second Provincial General Hospital, Guangzhou 510317, China

²Nursing Department, Guangdong Second Provincial General Hospital, Guangzhou 510317, China

³Clinical Research Department, Guangdong Second Provincial General Hospital, Guangzhou 510317, China

⁴Department of Nephrology, Guangdong Second Provincial General Hospital, Guangzhou 510317, China

Received: 2 July 2025 | Revised: 12 September 2025 | Accepted: 10 October 2025

ABSTRACT

Objective: Based on the structure-process-outcome (SPO) theoretical framework, this study aims to systematically construct a scientific, complete, and operable comprehensive evaluation index system for the service quality of “Internet+nursing care” for disabled elderly from three key dimensions: structural quality, service process, and outcome quality. **Methods:** On the basis of literature review and policy analysis, the index system was established by integrating authoritative opinions from two rounds of Delphi expert consultations. The Analytic Hierarchy Process (AHP) was used to calculate the weights of indicators at all levels, and Cronbach's α coefficient was applied for reliability testing. **Results:** Two rounds of Delphi expert consultations were conducted from November 2024 to January 2025. The expert activity coefficients were 0.85 (85% recovery rate in the first round) and 1.0 (100% recovery rate in the second round), respectively; the expert authority coefficient was 0.86; and Kendall's W coefficients were 0.201 and 0.128, respectively. The final evaluation index system for the service quality of “Internet+nursing care” for disabled elderly consisted of 3 first-level indicators, 17 second-level indicators, and 86 third-level indicators. **Conclusions:** The evaluation index system constructed in this study is both practical and scientific, providing a new method for evaluating the service quality of “Internet+nursing care” for disabled elderly, as well as beneficial theoretical basis and practical guidance for optimizing and improving their service quality.

KEYWORDS

structure-process-outcome (SPO) model, Internet+nursing care, disabled elderly, service quality

1 Introduction

According to statistics, by the end of 2023, nearly 200 million elderly people in China suffered from chronic diseases, accounting for 75% of the total elderly population [1], and about 45 million elderly people were in a disabled or semi-disabled state, accounting for 19.5% of the total elderly population [2]. Surveys show that 42.5% of the elderly need home medical services, of which 15.8% need home rehabilitation nursing services [3, 4]. As a new medical service model, “Internet+nursing care” has solved the problem of seeking medical treatment for elderly, disabled, and mobility-impaired patients. At present, there have been preliminary studies on the service quality of “Internet+nursing care” in

China, but there is no unified evaluation index for the service quality of “Internet+nursing care” for the disabled elderly. The structure-process-outcome (SPO) theory, which is the structure-process-result theoretical model, is the most commonly used medical nursing quality evaluation model at present [5–7]. Therefore, based on the SPO theory and the premise of effectively meeting the health care needs of disabled elderly [4, 8–10], this study comprehensively uses literature review [11–13], qualitative interviews, and Delphi expert consultation research methods [9, 14–16] to construct a scientific, systematic, and highly operable “Internet+nursing care” service quality index system for disabled elderly.

© The Author(s) 2025. *Aging Research* published by Tsinghua University Press. The articles published in this open access journal are distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

✉ Address correspondence to Yun Tong, merryxmas2009@yeah.net

Cite this article as Zhang, X. Q., et al. *Aging Research*, 2025, 3: 9340060.

2 Results

2.1 Basic information of inquiry experts

The consultation team is composed of 20 experts, 17 of whom participated in both rounds of consultation. The basic information of the participating experts is shown in Table 1.

2.2 Enthusiasm of inquiry experts

The enthusiasm of experts was quantitatively evaluated by the activity coefficient (that is, the questionnaire recovery rate), which reflects the degree of expert participation in the research. Referring to the standards in the literature [6, 11–13], the minimum acceptable recovery rate is 50%, and the good recovery rate is $\geq 70\%$. In this study, the recovery rate in the first round was 85%, and the recovery rate in the second round was 100%, indicating that the enthusiasm of experts to participate was at a high level.

2.3 Expert authority coefficient

The expert authority coefficient (Cr) serves as a crucial indicator for evaluating the reliability of expert opinions, calculated based on two dimensions: judgment basis (Ca) and familiarity (Cs). The formula is expressed as: $Cr = (Ca + Cs)/2$. The results of this study showed that the average authority score of 17 experts was 0.86, exceeding the benchmark threshold of 0.7. This fully confirms that the expert panel in this research demonstrates professional authority [5], and their opinions hold guiding value for the construction of the index system.

2.4 Expert coordination degree

The coefficient of variation (CV) and Kendall's coefficient of concordance (W) were used to evaluate the consistency level

of expert opinions: CV measures the degree of dispersion of experts' scores on a single index; W evaluates the consistency of the overall opinions of the expert group. The research results showed that: in the first round of consultation, $W = 0.601$ ($P < 0.001$); in the second round of consultation, $W = 6.128$ ($P < 0.001$), indicating that the opinions of 17 consulting experts were highly consistent, and the research results were highly reliable.

2.5 Index screening results

The main revision suggestions from expert consultation were as follows: (1) In the human resources section of structural indicators, supplement the validity of nurse practice certificates and special technical qualifications as tertiary index evaluation elements. Modify "nurse work experience" to "specialized work experience", and revise or delete overlapping items between "nurse visiting qualifications" and "total number of visiting personnel". In the facilities and equipment section, propose adding communication devices and visiting transportation. In environmental facilities, revise or delete the item "clean and odor-free living space for disabled elderly". (2) In the system construction section of structural indicators, add management of consumables and first-aid supplies, ethics-related systems, and referral systems. In the visiting process section, revise to include emergency consultation. In nursing skills, add educational capabilities. In daily living aid guidance, add training for self-care abilities such as dressing, toileting, and bathing. (3) In the health-related quality of life section of outcome indicators, integrate anxiety/depression and psychosomatic status into one item. In the patient/family/caregiver satisfaction section, combine satisfaction evaluations for patients, family members, and caregivers without separation. Based on expert feedback, the expression of some evaluation indicators was optimized to enhance the practicality and operability of the index system.

2.6 Determination of the index system

Through systematic literature and policy analysis, combined with the results of two rounds of Delphi expert consultations, a preliminary service quality evaluation system for "Internet+nursing care" for disabled elderly was constructed. It includes 3 first-level indicators: structural quality, process quality, and outcome quality; 17 second-level indicators: human resources, hardware equipment configuration, environmental facilities, management system construction, service standard system, job responsibilities, visiting process, nursing skills, rehabilitation nursing, guidance on daily living aids, incidence of patient complications, health-related quality of life, nursing safety quality, satisfaction of patients/families/caregivers, nurses' satisfaction, service qualification rate, and platform evaluation; and 86 third-level indicators. The Analytic Hierarchy Process (AHP) was used to calculate the weights of the indicator system. In the weight analysis at the same level, the coefficient of structural quality was 0.4, the coefficient of process quality was 0.2, and the coefficient of outcome quality was 0.4. The top three in the global weight ranking were the coefficient of operational technical complications (0.0481), the satisfaction with the reflection of nurses' professional values (0.0446), and the compliance of the information platform's qualification with national requirements and its complete functions (0.0378). For details, see Table 2.

Table 1 The basic information of the consulting experts

Project	Category	Number of people	Percentage
Gender	Male	2	11.76%
	Female	15	88.24%
Age (years)	~30	3	17.65%
	~40	8	47.06%
	~50	5	29.41%
	≥ 60	1	5.88%
	~10	4	23.53%
Work years	~20	10	58.82%
	~30	3	17.65%
Education	Undergraduate	11	64.71%
	Master	5	29.41%
	Doctor	1	5.88%
	Intermediate	4	23.53%
Title	Sub-senior	7	41.18%
	Senior	6	35.29%
Professional field	Nursing management	4	23.53%
	Chronic disease nursing	5	29.41%
	Community nursing	2	11.76%
	Geriatric nursing	6	35.29%

Table 2 Evaluation indicators for service quality of “Internet+nursing care” for disabled elderly

First-level indicators (weight)	Second-level indicators (weight)	Third-level indicators (weight)	Same-level weight	Global weight
A structural quality (0.4)	A1 human resources (0.1069)	A1-1 proportion of educational levels	0.1958	0.0084
		A1-2 proportion of professional titles	0.3108	0.0133
		A1-3 nurses' professional working experience	0.4934	0.0211
	A2 hardware facilities (0.2287)	A2-1 information platform's qualification complies with national requirements and has complete functions	0.4134	0.0378
		A2-2 equipped with safety protection equipment: positioning and tracking system, nurse work recorder, one-click alarm device, communication equipment, etc.	0.2608	0.0239
		A2-3 equipped with uniform clothing and special logos	0.1047	0.0096
		A2-4 equipped with special visiting kits and special medical waste disposal tools	0.1681	0.0154
		A2-5 equipped with special vehicles or vehicles contracted with large platforms	0.053	0.0048
	A3 environmental facilities (0.0741)	A3-1 safe, clean, and well-lit operating environment that meets requirements	0.3333	0.0099
		A3-2 provision of daily living appliances and safety facilities for service recipients	0.6667	0.0198
		A4-1 access system for nurses' qualification for Visiting services and training management	0.1146	0.0132
		A4-2 risk assessment and prevention and control system	0.1146	0.0132
	A4 management system construction (0.2881)	A4-3 infection prevention and control and medical waste management system	0.0801	0.0092
		A4-4 management and use specifications for medical consumables and first-aid supplies	0.0439	0.0051
		A4-5 emergency response plan for handling emergency and accidental situations	0.1146	0.0132
		A4-6 “blacklist” management system for service recipients	0.0293	0.0034
		A4-7 management system for nursing document writing	0.0579	0.0067
		A4-8 code of conduct for medical ethics	0.0579	0.0067
		A4-9 nurse exit management system	0.0801	0.0092
		A4-10 dual assessment system for service recipients	0.0579	0.0067
		A4-11 prevention and handling process for adverse events	0.0801	0.0092
		A4-12 privacy protection and information security management system	0.0579	0.0067
		A4-13 complaint handling system for service disputes	0.0439	0.0051
		A4-14 follow-up management system after visiting services	0.0337	0.0039
		A4-15 referral system	0.0337	0.0039
	A5 service standard system (0.1511)	A5-1 service standard system suitable for hospital operation	0.5	0.0302
		A5-2 formulation of personalized care plans for service recipients	0.25	0.0151
		A5-3 regular follow-up assessment	0.25	0.0151
	A6 job responsibilities (0.1511)	A6-1 job responsibilities for nursing management	0.25	0.0151
		A6-2 job responsibilities for visiting nurses	0.5	0.0302
		A6-3 job responsibilities for information platform	0.25	0.0151

(To be continued on the next page)

Table 2 (Continued)

First-level indicators (weight)	Second-level indicators (weight)	Third-level indicators (weight)	Same-level weight	Global weight
B process quality (0.2)	B1 visiting process (0.2685)	B1-1 timeliness rate of order assignment	0.0455	0.0024
		B1-2 completeness rate of item preparation	0.1596	0.0086
		B1-3 implementation rate of online and offline dual assessment	0.126	0.0068
		B1-4 signing rate of informed consent forms	0.1596	0.0086
		B1-5 compliance rate of operation implementation	0.2168	0.0116
		B1-6 completion rate of health education	0.0619	0.0033
		B1-7 timeliness rate of nursing document writing	0.0455	0.0024
		B1-8 completion rate of follow-up	0.0335	0.0018
		B1-9 qualification rate of emergency handling	0.0619	0.0033
		B1-10 qualification rate of medical waste disposal	0.0896	0.0048
	B2 nursing skills (0.4203)	B2-1 daily care service skills	0.0681	0.0057
		B2-2 specialist nursing skills	0.1552	0.0130
		B2-3 traditional Chinese medicine nursing skills	0.0322	0.0027
		B2-4 first-aid skills	0.2461	0.0207
		B2-5 assessment/diagnosis ability	0.207	0.0174
		B2-6 health management ability	0.0681	0.0057
		B2-7 psychological nursing ability	0.0681	0.0057
		B2-8 communication/coordination/multi-department cooperation ability	0.1552	0.0130
	B3 rehabilitation nursing (0.1899)	B3-1 rehabilitation exercise plan and evaluation	0.3333	0.0127
		B3-2 implementation rate of rehabilitation training measures	0.6667	0.0253
	B4 daily living aids guidance (0.1213)	B4-1 wheelchair transfer and use	0.5	0.0121
		B4-2 crutch use	0.25	0.0061
		B4-3 guidance on self-care ability	0.25	0.0061
C outcome quality (0.4)	C1 patient complication rate (0.1503)	C1-1 operational technical complications	0.8	0.0481
		C1-2 readmission rate	0.2	0.0120
	C2 health-related quality of life (0.0563)	C2-1 assessment of self-care ability in daily life	0.123	0.0028
		C2-2 assessment of physical and mental health status	0.0869	0.0020
		C2-3 assessment of venous thrombosis risk	0.0695	0.0016
		C2-4 assessment of pressure injury	0.1678	0.0038
		C2-5 fall assessment	0.2289	0.0052
		C2-6 nutritional assessment	0.1034	0.0023
		C2-7 quality of life assessment	0.0528	0.0012
		C2-8 assessment of caregivers' care ability	0.1678	0.0038

(To be continued on the next page)

Table 2 (Continued)

First-level indicators (weight)	Second-level indicators (weight)	Third-level indicators (weight)	Same-level weight	Global weight
C outcome quality (0.4)	C3 nursing safety quality (0.2144)	C3-1 mastery rate of fall prevention measures	0.1492	0.0128
		C3-2 mastery rate of pressure injury prevention measures	0.0967	0.0083
		C3-3 mastery rate of measures for handling catheter dislodgement	0.2036	0.0175
		C3-4 mastery rate of aspiration prevention measures	0.2036	0.0175
		C3-5 mastery rate of bed fall prevention measures	0.0967	0.0083
		C3-6 mastery rate of scald prevention measures	0.0967	0.0083
		C3-7 mastery rate of health education knowledge for special operations	0.0567	0.0049
		C3-8 mastery rate of asphyxia prevention and first-aid handling	0.0967	0.0083
	C4 patient/family/caregiver satisfaction (0.0563)	C4-1 satisfaction of patients/families/caregivers with service attitude	0.1089	0.0025
		C4-2 satisfaction of patients/families/caregivers with service technical level	0.3512	0.0079
		C4-3 satisfaction of patients/families/caregivers with overall nursing effect	0.3512	0.0079
		C4-4 satisfaction of patients/families/caregivers with information platform operation	0.1887	0.0042
	C5 Nurse Satisfaction (0.2838)	C5-1 satisfaction with information platform operation	0.2338	0.0265
		C5-2 satisfaction with the safety and convenience of special vehicles	0.139	0.0158
		C5-3 satisfaction with practice safety guarantee measures	0.2338	0.0265
		C5-4 satisfaction with the reflection of nurses' professional values	0.3933	0.0446
	C6 service qualification rate (0.1503)	C6-1 timeliness rate of service completion	0.1567	0.0094
		C6-2 qualification rate of nursing technical operations	0.505	0.0304
		C6-3 qualification rate of nursing documents	0.2452	0.0147
		C6-4 implementation rate of follow-up	0.0931	0.0056
	C7 platform evaluation (0.0886)	C7-1 information platform's satisfaction with nurses	0.25	0.0089
		C7-2 Information platform's timeliness rate in handling complaint incidents	0.75	0.0266

3 Discussion

3.1 The service quality evaluation indicator for "Internet+nursing care" for disabled elderly has good theoretical consistency and scientificity

This study is based on the SPO theory [5], comprehensively adopts methods such as systematic literature review and semi-structured interviews to initially establish the indicator framework [6–9], uses the results of the Delphi expert consultation, and combines the indicator selection criteria to construct the service quality evaluation indicators for "Internet+nursing care" for disabled elderly. The Analytic Hierarchy Process is used to calculate the weights of the indicators at all levels, and the experts' evaluation opinions are objectively presented through quantitative values. The SPO theory has been widely used in the construction of nursing quality evaluation indicators, and its scientificity has been

widely recognized by the society [12]; the systematic literature review helps to understand the development status, existing problems, factors affecting quality improvement, and relevant links of the service quality of "Internet+nursing care" for disabled elderly, laying a foundation for the preliminary formulation of indicators [17–20]; through semi-structured interviews, the completeness and particularity of the evaluation elements are taken into account in the indicator construction, the results of the literature review are supplemented and revised, and the indicator structure is determined. The Delphi method is currently widely used in studies on the establishment of nursing quality evaluation indicators [4], and the selection of experts is the key to the Delphi method. However, the research on "Internet+nursing care" in China is not in-depth enough, and the research content involved is relatively limited [4, 11, 20]. Therefore, in the selection of experts in this study, factors such as educational background, professional title, professional

research field, and working experience, as well as the degree of familiarity with the field of “Internet+nursing care” were fully considered to ensure that the evaluation indicators have theoretical support and conform to the policy orientation, making the consultation results more reasonable. In the two rounds of expert consultations in this study, the experts attached great importance to the research, had relatively unified opinions on the indicators, and the consultation results were reliable. In addition, the Analytic Hierarchy Process was used to calculate the weight coefficients of the constructed first-level, second-level, and third-level indicators, and consistency verification was conducted. The weight distribution of the indicators at all levels is scientific and reasonable, and the experts’ judgments have a high degree of consistency, so the research results have high credibility.

3.2 The comprehensiveness and practicality of the service quality evaluation index system for “Internet+nursing care” for disabled elderly

“Internet+nursing care” requires nurses to practice independently in patients’ homes away from medical institutions. How to ensure the medical quality of “Internet+nursing care”, the safety of patients, and the personal safety of nurses is the focus of the industry [13, 18]. The quality of nursing services for disabled elderly has multiple strategic values. Firstly, it directly affects the quality of life of the elderly [11]; secondly, it has guiding significance for meeting the personalized health care needs of the people [20]; in addition, it plays a positive role in promoting the innovation of disabled care technology, the cultivation of specialized nursing services, and the research and development of core care technologies [16].

This study formed 3 first-level indicators, 17 second-level indicators, and 86 third-level indicators. The evaluation of the structural quality dimension mainly adopts objective quantitative standards. From the perspective of service-providing institutions, it systematically evaluates the comprehensive service capabilities of home care institutions, including six core elements. The evaluation system of the process quality dimension adopts a combination of subjective and objective measurement methods. From the perspective of service recipients, it comprehensively examines the service quality level of home care institutions, covering four key service links; the service effect quality dimension adopts an outcome-oriented evaluation method to systematically evaluate the overall nursing quality of disabled elderly from multiple dimensions. Through retrospective analysis, it objectively and accurately reflects the implementation effect and service quality of “Internet+nursing care” in the disabled elderly group, focusing on monitoring seven key indicators.

3.3 Efficiency, economy, and scene adaptability of the service quality evaluation index system for “Internet+nursing care” for disabled elderly

From the perspective of efficient and economic application, hierarchical application can be carried out according to the indicator situation. In the conventional monitoring scenario, a subset of core indicators is extracted. In the structural quality

dimension, indicators that play a significant role in the basic guarantee of services, such as nurses’ professional working experience and the compliance of the information platform’s qualification with national requirements and its complete functions, are selected; in the process quality dimension, key service link indicators such as the compliance rate of operation implementation and the completion rate of health education are focused on; in the outcome quality dimension, core outcome indicators such as operational technical complications and the satisfaction of patients/families/caregivers with the overall nursing effect are selected. These subsets of core indicators cover the key dimensions of services, can meet the basic needs of conventional monitoring, and can also reduce costs. In the in-depth evaluation scenario, the complete indicator system is activated to conduct a comprehensive and detailed evaluation of structural quality, process quality, and outcome quality, in-depth analyze the advantages and disadvantages of “Internet+nursing care” in the care of disabled elderly, and provide a basis for the optimization and upgrading of services, so as to realize flexible and accurate application in different scenarios.

4 Conclusions

The service quality evaluation index system for “Internet+nursing care” for disabled elderly comprehensively uses subjective and objective evaluation indicators, and combines qualitative and quantitative methods to evaluate the service quality of “Internet+nursing care” for disabled elderly, ensuring that the indicators are specific, operable, targeted, and practical. This study also discusses the safety and user experience of the support system to evaluate the legitimacy of the information platform, data security, privacy protection, and the completeness of the monitoring and alarm functions. Compared with most domestic studies that only rely on single-dimension analysis, this study starts from the practical operation of “Internet+nursing care”, integrates the perspectives of patients/caregivers, medical staff, and information platforms, and constructs a quality evaluation system for “Internet+nursing care” for disabled elderly, which can more scientifically and accurately reflect the actual situation of service quality and the existing problems, effectively make up for the limitations of existing studies, and provide a more objective and true basis for the improvement of the quality of “Internet+nursing care”. The consulting experts in this study are from six provinces including Guangdong, Hunan, Jiangxi, Sichuan, Guizhou, and Yunnan, which belong to the two major regional plates of South China and Southwest China, and have certain regional limitations. When promoting the application nationwide, regional adjustments and verification studies are needed. In the next step, this evaluation index will be used to conduct comprehensive implementation verification in “Internet+nursing care”, continuously optimize the service quality standard system for disabled elderly, add dimensions such as digital user experience and the integration of online and offline services, so as to promote the construction of a continuous improvement mechanism for service quality and provide empirical basis for Guangdong Province and even the country to formulate industry standards.

5 Materials and methods

5.1 Data sources

The indicators mainly come from the Ministry of Civil Affairs' "Specifications for Ability Assessment of the Elderly" (MZ/T 039-2013), the State Administration for Market Regulation and the Standardization Administration of China's "Community Home-based Elderly Care Service Specifications" (GB/T 35796-2017), the China Association for Standardization's "Internet+Nursing Care Part 1: General Rules" (T/CAS 1.1-2020), the China Association for Standardization's "Internet+Nursing Care Part 2: Home Nursing Service Specifications" (T/CAS 1.2-2020), the China Association for Standardization's "Internet+Nursing Care Service Quality Evaluation Specifications" (T/CAS 1.3-2021), and the Shenzhen Market Supervision Administration's "Home Nursing Service Specifications" (DB4403/T 107—2020) and other policy documents.

5.2 Research methods

5.2.1 Establishment of a research team

A 10-person research team composed of multidisciplinary experts was formed, including 4 senior nursing experts (3 chief nurses and 1 associate chief nurse), 1 medical expert (chief physician), 4 clinical nursing backbones (2 nurses and 2 charge nurses), and 1 technical support expert (senior engineer), all with a bachelor's degree or above. Senior title experts are responsible for research framework design, questionnaire preparation, selection of consulting experts, and quality control management, while the rest of the members are responsible for literature review, semi-structured interviews, questionnaire distribution and collection, and summarization, analysis, discussion, and revision of feedback opinions.

5.2.2 Preliminary formulation of evaluation indicators

5.2.2.1 Literature review

Using "Internet+nursing service/net nursing/disabled elderly/nursing quality/evaluation index/index system/quality evaluation/quality index/nursing quality index/nursing quality evaluation index/nursing quality sensitive index" as Chinese search terms, and "home health nursing", "home care nurse", "hospital in the home", "visiting nurse", "online appointment nurse", "aged", "elderly", "disabled person", "quality indicators", "quality of care", "nursing-sensitive indicators" as English search terms, we searched PubMed, Web of Science, Cochrane Library Databases, ISTA, Library of Congress, Acad Search Prem, Wanfang Database, CNKI, and VIP Database. The core concepts and quality evaluation standards of "Internet+nursing services" in the field of disabled elderly care were systematically combed [5–6, 8–11], the evaluation index framework was preliminarily established, and a semi-structured interview plan was formulated.

5.2.2.2 Semi-structured interview

According to the results of literature review [6, 16–20] and research purposes, 2 operation managers responsible for "Internet+nursing services", 2 nurses with practical experience in home nursing services, 2 doctors engaged in

disabled-related work, and 2 disabled elderly people receiving "Internet+nursing services" and their caregivers were selected for pre-testing. Expert suggestions were consulted on the problems found in the interview process, and the formal interview outline was finally formed through repeated study, analysis, and revision.

Interview outline for nursing managers, nurses, and doctors: a) How many years has your hospital carried out "Internet+nursing services"; what are the specific service items; are there special service contents for disabled elderly; what is the total number of services. b) How does your hospital evaluate the service quality of "Internet+nursing services" for disabled elderly; what are the specific observation indicators and evaluation tools. c) What factors do you think affect the service quality of disabled elderly in the whole process of "Internet+nursing services"; what improvement suggestions do you have for improving service quality; d) What aspects do you think should be used to optimize the evaluation service quality system and other suggestions

Interview outline for patients and caregivers: a) How long have you received "Internet+nursing services"; are you satisfied with the services; do you have any suggestions. b) What do you think is the difference between going to the hospital; what are you most worried about. c) What kind of services do you expect "Internet+nursing services" to provide for you. d) When you use "Internet+nursing services", what key elements will affect your service perception or user experience; e) What services for disabled elderly do you hope to add on the basis of the existing "Internet+nursing services"; which aspects need to be strengthened; f) If you are asked to evaluate "Internet+nursing services"; which aspects will you focus on.

A stratified sampling method was used to select disabled elderly people receiving "Internet+nursing services" and their caregivers, "Internet+nursing services" visiting nurses, "Internet+nursing services" managers, and doctors engaged in disabled-related work from a tertiary hospital in Guangdong Province, Ganzi Prefecture People's Hospital in Sichuan Province, Jinggangshan People's Hospital in Jiangxi Province, and Fuquan People's Hospital in Guizhou Province for interviews. The interview process was recorded by audio, and a single interview was controlled within 30–45 minutes. The sample size was based on the repetitive characteristics of the interview content, and no new core concepts were found in the data analysis.

The following criteria were used to select interview subjects. Disabled elderly: a) elderly people aged ≥ 60 years with different degrees of limitation in daily life functions (evaluated according to the Activities of Daily Living Scale recommended by the World Health Organization); b) who have received "Internet+nursing services" for three months or more; c) for those with consciousness disorders, cognitive impairment, or inability to complete the questionnaire independently, their caregivers shall assist in completing it uniformly; d) who are informed about this study and voluntarily accept evaluation and questionnaire survey. Caregivers of disabled elderly: a) who are informed about this study and voluntarily accept evaluation and questionnaire survey; b) who have cared for disabled elderly receiving "Internet+nursing services" for three months or more; c) who have unimpeded

communication and expression. Visiting nurses: a) with a nurse practitioner certificate; b) with more than 3 years of work experience or have obtained the title of nurse; c) who have received training in “Internet+nursing services” and have obtained the qualification for visiting for ≥ 1 year; d) who are informed about this study and voluntarily accept evaluation and questionnaire survey. Nursing managers: a) who have served as head nurse or deputy director/director of the nursing department for ≥ 3 years; b) who have ≥ 1 year of experience in operation and management of “Internet+nursing services”; c) who are aware of the research content and voluntarily accept the survey. Doctors: a) who have been engaged in geriatric and related clinical work for ≥ 3 years or have obtained the title of attending physician; b) who are aware of the research content and voluntarily accept the survey.

After the interview, two personnel completed the text entry, verification, and analysis of the audio data, and used the Colaizzi seven-step analysis method to include “good professional skills of service personnel”, “simple operation of the ordering platform”, “guidance on daily living aids for disabled elderly”, “prevention and assessment of risks such as aspiration, falls, and pressure ulcers”, and “safety of visiting nurses” in the evaluation indicators. Combining the three core dimensions of the SPO model and their theoretical connotations, and strictly following the policy documents such as the “Implementation Plan for the Pilot Work of ‘Internet+Nursing Services’” and the “Quality Evaluation Specifications for ‘Internet+Nursing Services’” promulgated by the state and Guangdong Province, an evaluation index framework for the service quality of “Internet+nursing services” for disabled elderly was initially constructed, including 3 first-level indicators, 15 second-level indicators, and 93 third-level indicators.

5.2.2.3 Formulation of expert inquiry questionnaire

Eight clinical and management experts with senior titles in the fields of “Internet+nursing services” and treatment and nursing of disabled elderly were selected to participate in the questionnaire revision work. They focused on putting forward modification suggestions on the design of the system structure, the setting of index items, and the expression of contents. In the “human resources” dimension of structural quality indicators, the repeated indicators “nurse practice certificate is valid” and “nurse visiting qualification” were merged into “nurse visiting qualification”; the second-level index “environmental facilities” was added, including “the living place is clean and tidy, free of odor”, “the operating environment is safe, clean, and the light is good and meets the requirements”, and “the living utensils and safety facilities for disabled elderly are equipped”; in the “rehabilitation nursing” dimension of process indicators, “continuous exercise of the remaining abilities of disabled elderly” was added; in the “health-related quality of life” dimension of outcome quality indicators, “nutrition score, quality of life score, and caregiver care ability score for disabled elderly” indicators were added; the second-level index “platform evaluation” was added, including “platform satisfaction with nurses” and “platform timely handling rate of complaints”. After the second round of expert consultation and systematic revision, the inquiry content of the three-level quality evaluation index was

determined, including 3 first-level indicators, 17 second-level indicators, and 86 third-level indicators. The final questionnaire included 3 structured modules: (1) Preface: explaining the research background, purpose and significance, importance of experts, filling instructions, questionnaire collection time, and ethical principles. (2) Theme: list the “Evaluation Indicators for the Service Quality of ‘Internet+Nursing Care’ for Disabled Elderly” in layers and groups, evaluate the importance of each index item, and put forward modification suggestions. The Likert five-level scoring was used, and five options (very important, relatively important, generally important, not very important, and very unimportant) were provided, with scores of 5, 4, 3, 2, and 1 in turn. (3) General information of experts: including work unit, current position, professional and technical title, main work field, highest education, etc., and an expert authority degree questionnaire was attached, including a judgment basis survey (theoretical analysis, practical experience, etc.) and a familiarity survey (very familiar to very unfamiliar).

5.2.2.4 Expert consultation

Selection of Experts: Twenty experts were invited to participate in the Delphi consultation, coming from six provinces including Guangdong, Hunan, Jiangxi, Sichuan, Guizhou, and Yunnan, and working in tertiary general hospitals, secondary medical institutions, community medical and health service institutions, and nursing stations. The inclusion criteria were: (1) engaged in nursing management, practice, education, and research related to “Internet+nursing care”; (2) engaged in geriatric medical treatment, clinical nursing, geriatric nursing management, or geriatric nursing education; (3) having a bachelor’s degree or above and a title of nurse practitioner or above; (4) willing to participate in this study, sign the informed consent form, and be willing to provide comprehensive professional opinions and suggestions.

Implementation of Consultation: Two rounds of expert consultations were conducted from December 2024 to January 2025. During the questionnaire distribution, multiple methods such as WeChat, E-mails, and in-person delivery were provided, and the recovery period was set to 1 month. A dual quality control was implemented for the recovered questionnaires. First, researchers checked the completeness of each questionnaire one by one, and then confirmed the questionable items on the spot. The survey was terminated when the experts’ opinions tended to be consistent (coefficient of variation < 0.30) after two rounds of consultation. The criteria for indicator selection were: (1) the average score of importance assessment ≥ 4 points and the full-score rate $> 20\%$; (2) the expert consensus degree, i.e., the coefficient of variation (CV) < 0.30 . Through interdisciplinary research group meetings, the opinions from the Delphi expert consultation and the professional evaluation results of the research team were integrated to finally determine the indicators included in the formal evaluation system.

5.3 Statistical methods

Excel 13.0 was used for double independent data entry, and SPSS26.0 software and SPSSAU3.0 software were used for statistical analysis. Analysis of expert consultation results: (1) Concentration of opinions: the consistency of expert opinions

was evaluated by calculating the mean value, standard deviation, and coefficient of variation (CV) of the importance score of each index. The higher the mean value and the lower the CV value, the higher the expert consensus; (2) Expert authority degree: $Cr = (\text{judgment basis score } Ca + \text{familiarity score } Cs)/2$; (3) Opinion coordination degree: Kendall's W test was performed using the coefficient of variation (CV) and Kendall's coefficient of concordance (W), with $P < 0.05$ as statistically significant. The analytic hierarchy process and percentage weight method were used to determine the weights of the index system, and the reliability and validity of the index system were tested using the Cronbach's coefficient and Pearson correlation coefficient r .

Consent to participate

The volunteer was enrolled with written informed consent. The participant who had the ability to communication with the investigator agreed to participate in the study. The informed consent was obtained in written form.

Ethics approval

The Affiliated Guangdong Second Provincial General Hospital of Jinan University approved this study (Approval ID: 2024-KY-KZ-031-02).

Author contributions

Yun Tong was responsible for the conception and overall design of the study, whereas Yun Tong, Xiaoqin Zhang and Li Tang collaborated on conceptualization, data management, and methodology and contributed to the writing. In addition, Lingna Yu, Ting Jiang and Yingwen Li performed the formal analysis and participated in the review and editing process of the manuscript.

Funding

Nursing Quality Improvement and Innovation Research Fund of Guangdong Second Provincial General Hospital, No. YH2023-2.

Conflict of interests

The authors declare that they have no conflict of interests.

References

- [1] China Health Statistics Yearbook 2023. Available at: https://www.nhc.gov.cn/mohwsbwstjxxzx/tjtjnj/202501/8193a8edda0f49df80e-b5a8ef5e2547c/files/1740022743894_10341.pdf
- [2] 2023 National Aging Undertakings Development Report. Available at: <https://www.gov.cn/lianbo/bumen/202410/P0202410123076026-53540.pdf>
- [3] 2023-2029 China Elderly Health Service Market Comprehensive Research and Development Trend Analysis Report. Available at: https://pdfs.cir.cn/YiYaoBaojian/96/%e8%80%81%e5%b9%b4%e5%81%a-5%e5%ba%b7%e6%9c%8d%e5%8a%a1%e8%a1%8c%e4%b8%9a%e5%8f%91%e5%b1%95%e8%b6%8b%e5%8a%bf_2680396.pdf
- [4] General Office of the National Health Commission. Notice of the General Office of the National Health Commission on Further Strengthening Nursing Work in Medical Institutions. Guo Wei Ban Yi Fa (2020) No. 11. Beijing: General Office of the National Health Commission, 2020. Available at: https://www.gov.cn/zhengce/zhengceku/2020-09/02/content_5539428.htm
- [5] Tang, C. H., Wang, A. Q., Yan, J. J. Exploring motivations and resistances for implementing shared decision-making in clinical practice: A systematic review based on a structure–process–outcome model. *Health Expectations*, 2022, 25(4): 1254–1268. <https://doi.org/10.1111/hex.13541>
- [6] Tan, Q. H. Construction of a quality evaluation index system for "Internet + Nursing Care" based on the Quality Three-Ring Theory. Master Dissertation. Changsha, Hunan Normal University, 2020.
- [7] Tian, Y. T., Zhang, Y., Hou, X. H., Ren, H. Y., Zhang, Y. L., Niu, S. Q., Qiu, X. H., Tan, H. Y. Construction and Application Research of "Internet+Nursing Care" Platform. *Chinese Journal of Nursing*, 2020, 55(10): 1537–1542. (in Chinese) <https://doi.org/10.3761/j.issn.0254-1769.2020.10.017>
- [8] Ren, Z. F., Gao, X. L., Wang, Y. L., Zhang, L. L., Xiao, Q. Construction of a quality evaluation index system for "internet+nursing care" based on the three-dimensional quality theory and service quality evaluation model. *Chinese Nursing Management*, 2022, 22(3): 391–396. (in Chinese) <https://doi.org/10.3969/j.issn.1672-1756.2022.03.014>
- [9] Ye, L., Yang, S. L., Jiang, B. Y., Liu, C. X., Jin, X. Q., Chang, P. L. Developing a quality indicator system for evaluating Internet plus home care nursing services based on the SERVQUAL model: A Delphi-analytic hierarchy process study. *PeerJ*, 2024, 12: e18281. <https://doi.org/10.7717/peerj.18281>
- [10] Ma, M. F., Li, D. S., Zhou, L., Wu, F., Duan, Z. J. Dai, Y. Construction of a quality evaluation index system for "Internet+nursing care" based on the SERVPERF model. *Chinese General Practice Nursing*, 2025, 23(9): 1585–1590. (in Chinese) <https://doi.org/10.12104/j.issn.1674-4748.2025.09.001>
- [11] Li, X. N. Research progress on the construction of a quality evaluation system for "internet+nursing care". *Chinese Nursing Management*, 2023, 23(7): 1095–1099. (in Chinese) <https://doi.org/10.3969/j.issn.1672-1756.2023.07.028>
- [12] Yuan, S., Liu, M., Peng, Y. Q., Hu, J. R., Li, B. Y., Ding, X., Xie, L. F. "Internet+Nursing service" mobile apps in China app stores: Functionality and quality assessment study. *JMIR MHealth and UHealth*, 2024, 12: e52169. <https://doi.org/10.2196/52169>
- [13] Wang, X. H., Chen, J. Y., Feng, M. Q., Zhuang, M. Q., Wang, J. Y., Zhang, L. Y., Liu, Y., Chen, H. F. Demand and influencing factors of "Internet + Traditional Chinese Medicine" home nursing service for older adult patients with chronic diseases: A mixed research perspective. *Frontiers in Public Health*, 2023, 11: 1271082. <https://doi.org/10.3389/fpubh.2023.1271082>
- [14] Wang, X. R., Chen, Y., Wang, Q., Xia, D. Y., Xu, L. Research on quality evaluation indicators of "internet+nursing care" based on the service quality gap model. *Chinese Journal of Nursing*, 2021, 56(9): 1369–1376. (in Chinese) <https://doi.org/10.3761/j.issn.0254-1769.2021.09.015>
- [15] Peng, J. L., Yang, Q. Construction of a quality evaluation system for "Internet+nursing care". *Nursing Research*, 2024, 38(7): 1253–1261. (in Chinese) <https://doi.org/10.12102/j.issn.1009-6493.2024.07.020>
- [16] Yong, Y., Ming, Y., Xia, C., Long, Z. Construction and application of the "Internet + public health service" supply evaluation index system. *PLoS One*, 2024, 19(2): e0293341. <https://doi.org/10.1371/journal.pone.0293341>
- [17] Shi, C. N., Guo, X. L., Sun, K. L., Chen, F. F., Xu, Q., Liu, C. B., Sheng, Z. R. Application and effect analysis of standardized nursing service procedures in "Internet + nursing service". *Hospital Management Forum*, 2023, 40(10): 65–70. (in Chinese) <https://doi.org/10.3969/j.issn.1671-9069.2023.10.015>
- [18] Ren, Z. F., Tong, L., Jin, S., Wang, Y. L., Xiao, Q. Nurses' experiences of Internet + nursing service based on service quality: A qualitative study. *Studies in Health Technology and Informatics*, 2024, 315: 695–696. <https://doi.org/10.3233/SHIT1240284>
- [19] Liu, S. S., Li, H., Wang, X. P., Deng, L. L., Qiao, Y., Feng, X., Zhao, L. Construction of a quality evaluation index system for "Internet+home nursing services" based on the Donabedian Theory. *Chinese Journal of Geriatric Health Care*, 2024, 22(6): 163–167. (in Chinese) <https://doi.org/10.3969/j.issn.1672-2671.2024.06.040>
- [20] Wang, Y., Liu, Y., Wang, Q., Li, X. F. Research progress on quality assessment tools for "Internet+Nursing care". *Chinese General Practice Nursing*, 2023, 21(29): 40904093. (in Chinese) <https://doi.org/10.12104/j.issn.1674-4748.2023.29.014>