Supplementary File 1 – Full English Versions of All Survey Instruments

Survey on Digital Exclusion Behavior Among Older Patients Throughout the Entire Medical Treatment Process in Smart Healthcare Scenarios

Dear participant,

This survey is part of a research study titled "Heterogeneity of Digital Exclusion Behavior Among Older Patients Throughout the Entire Medical Treatment Process in Smart Healthcare Scenarios" conducted by the research team at Shandong Provincial Hospital Affiliated to Shandong First Medical University. The purpose of this study is to investigate the current status, root causes, and influencing factors of digital exclusion behaviors among older patients across the entire smart healthcare journey. The findings will provide empirical evidence for developing stratified, targeted, and age-friendly digital health interventions in hospital settings.

This survey consists of three sections. Your participation is entirely voluntary. You have the right to refuse to participate or withdraw from the survey at any time without providing any reason and without any negative consequences. All responses will be anonymized and treated with strict confidentiality. The data collected will be used solely for academic research purposes and will not be used for any other purposes. No individual identifying information will be disclosed in any publications or reports.

There are no right or wrong answers—please select the option that best reflects your actual experience. The survey takes approximately 15–20 minutes to complete. If you have any questions, concerns, or complaints about this study, please contact the corresponding author: Ying Guo, MSN, RN, Chief Nurse, Department of Surgery, Shandong Provincial Hospital Affiliated to Shandong First Medical University, Email: guoyingslyy@163.com.

By completing and submitting this survey, you indicate that you have read and understood the above information and consent to participate in this study. If you have difficulty reading or completing the questionnaire on your own, please do not hesitate to ask the researcher or your family members for assistance. The research staff are trained to read each item aloud and record your responses based on your verbal feedback, ensuring that your answers faithfully reflect your actual experience.

Thank you for your time and valuable contribution.

— The Research Team

Instrument 1: General Sociodemographic Questionnaire

Instructions:

This section collects basic background information to help us better understand the characteristics of our study population. Please read each item carefully and select or fill in the option that best describes your current situation. All responses will be used solely for statistical analysis and will remain strictly confidential. There are no right or wrong answers—please answer according to your actual circumstances.

1. Gender [Single choice]

○ Male

○ Female

2. Age (in years) [Fill-in]

3. Education level [Single choice]

○ Primary school or below

○ Junior high school

○ High school / technical secondary school

○ College degree or above

4. Residence [Single choice]

○ Urban

○ Rural / township

5. Living arrangement [Single choice]

○ Living alone

○ Not living alone

6. Per capita monthly household income [Single choice]

○ < 3,000 RMB

○ 3,000–5,000 RMB

○ > 5,000 RMB

7. Types of smart devices owned [Multiple choice]

○ None

○ One type

○ Two or more types

8. Average daily duration of smart device use [Single choice]

○ < 1 hour

○ 1–2 hours

○ > 2 hours

○ Almost never

9. Range of digital health services used [Multiple choice]

○ Never used

○ 1–2 types

○ ≥ 3 types

10. Number of chronic diseases [Single choice]

○ None

○ 1 – 2 conditions

○ 3 conditions or more

11. Years of smartphone use [Single choice]

○ Never used

○ < 1 year

○ 1–3 years

○ > 3 years

Instrument 2: Self-developed Scale for Digital Exclusion Behaviors of Older Patients in Smart Healthcare Settings

Instructions:

This 20-item, 4-point Likert scale quantifies digital exclusion severity by measuring usability barriers across 20 distinct digital healthcare services covering pre-visit, in-hospital, and post-discharge stages. Higher total scores indicate more severe digital exclusion. Item scoring criteria and behavioral definitions are specified as follows.

- Score 1: fully independent completion of all digital healthcare operations;
- Score 2: autonomous completion of most operations, with assistance needed only for isolated procedures;
- Score 3: complete inability to operate independently, with full delegation to family caregivers;
- Score4: neither the patient nor family caregivers can complete digital operations, requiring exclusive reliance on healthcare staff assistance.

For each item, please select the option that best describes the extent to which you were able to complete the digital operation on your own. If you did not use a particular service during your most recent visit, please base your answer on your general experience or your perceived ability to use it.

Scoring criteria:

Pre-visit Stage

Item	Score 1	Score 2	Score 3	Score 4
1. **Online outpatient appointment** (e.g., booking a visit via smartphone app or mini-program)	○	○	○	○
2. **Online medical insurance verification** (e.g., completing off-site insurance registration or reimbursement applications)	○	○	○	○
3. **In-hospital navigation** (e.g., locating clinic buildings, departments, or examination rooms via mobile map)	○	○	○	○

4. **Mobile payment for medical services** (e.g., paying registration fees, medication costs, or examination charges)	○	○	○	○
5. **Medical expense inquiry** (e.g., checking and verifying itemized billing records online)	○	○	○	○
6. **Examination appointment** (e.g., scheduling or rescheduling CT, ultrasound, or MRI scans)	○	○	○	○
7. **Electronic medical record inquiry** (e.g., viewing or printing outpatient medical records electronically)	○	○	○	○
8. **Laboratory test report inquiry** (e.g., downloading or printing blood test, urine test, or pathology reports)	○	○	○	○

In-hospital Stage

Item	Score 1	Score 2	Score 3	Score 4
9. **Online inpatient admission** (e.g., completing admission forms and registration via smartphone or self-service kiosk)	○	○	○	○
10. **Inpatient payment** (e.g., paying hospitalization deposits or medical bills during hospital stay)	○	○	○	○
11. **Medical record access** (e.g., downloading electronic medical records or imaging reports during hospitalization)	○	○	○	○
12. **Bedside discharge settlement** (e.g., completing discharge procedures and final billing using bedside terminals)	○	○	○	○

Post-discharge Stage

Item	Score 1	Score 2	Score 3	Score 4
13. **Two-way referral application** (e.g., applying for upward referral to a higher-level hospital or downward referral to a primary care facility)	○	○	○	○
14. **Medication reminder viewing** (e.g., receiving and checking medication reminders via SMS or app notifications)	○	○	○	○
15. **Health data uploading** (e.g., uploading blood pressure, blood glucose, or other monitoring data via connected devices)	○	○	○	○
16. **Smart follow-up participation** (e.g., participating in automated phone follow-up or completing online health questionnaires)	○	○	○	○

17. **Health science video viewing** (e.g., watching educational videos on disease prevention or chronic disease management)	○	○	○	○
18. **Health information push notifications** (e.g., receiving health tips, appointment reminders, or policy updates via mobile app)	○	○	○	○
19. **Online return visit appointment** (e.g., booking a follow-up visit after discharge through online platforms)	○	○	○	○
20. **Internet-based outpatient follow-up** (e.g., having remote consultations via online clinic services instead of in-person visits)	○	○	○	○

Instrument 3: Questionnaire on Root Causes of Digital Exclusion in Smart Healthcare for Older Adults

Instructions:

This mixed-format questionnaire, comprising both closed-ended matrix items and open-ended supplementary questions, contains 14 items distributed across three dimensions:

- Digital access infrastructure: smart terminal hardware, hospital Wi-Fi coverage, on-site self-service equipment allocation, and other environmental foundations;
- Individual digital capacity: physical function, operational self-efficacy, economic status, and external digital training and guidance;
- Digital service experience: system interface design, voice interaction functions, on-site patient navigation staffing, offline manual window availability, and other service safeguards.

Items were scored on a 3-point Likert scale (3=yes, 2= uncertain, 1= no), with higher scores denoting stronger obstructive effects on digital healthcare utilization. Please note that there are no right or wrong answers. Your honest responses will help us better understand the real-world barriers faced by older patients and inform the development of more age-friendly smart hospital services. If you are unsure about any item, please select the option that best reflects your general impression.

Digital Access Infrastructure

Item	Yes	No	Uncertain
1. My smartphone or network device has low specifications (e.g., insufficient memory, outdated system).	○	○	○
2. The hospital's public area network signal is unstable (e.g., difficulty connecting to Wi-Fi).	○	○	○
3. The number of self-service terminals is insufficient, leading to long waiting times.	○	○	○

Individual Digital Capacity

Item	Yes	No	Uncertain
4. Due to visual/hearing impairment, I cannot see the screen clearly or hear voice prompts.	○	○	○
5. Due to hand tremors or joint pain, I have difficulty operating touchscreen devices.	○	○	○
6. I worry that operational errors (e.g., incorrect payment) may cause financial loss.	○	○	○
7. I am concerned about personal information leakage or online fraud.	○	○	○
8. I cannot afford the cost of purchasing smart devices or paying for mobile data plans.	○	○	○
9. I give up using smart devices because the operating procedures are too complex.	○	○	○
10. I lack patient guidance from children or other relatives.	○	○	○
11. The hospital provides insufficient digital service training.	○	○	○

Digital Service Experience

Item	Yes	No	Uncertain
12. The hospital's digital interface has excessively small fonts and complex operation pages.	○	○	○
13. The voice interaction function of hospital self- service devices is not sensitive or has difficulty recognizing dialects.	○	○	○
14. There are too few staff members available on- site to assist with digital operations.	○	○	○
15. Offline manual service windows at the hospital have been excessively reduced.	○	○	○

Other Causes (please specify)

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— End of Supplementary File 1 —