Patient Preference and Adherence

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ORIGINAL RESEARCH

Applying the COM-B Model to Understand Adherence to Tele-Exercise Prehabilitation Among Older Patients with Lung Cancer: A Qualitative Study

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Objective: To investigate the factors influencing adherence to exercise prehabilitation among elderly frail lung cancer patients under telemedicine management within the COM-B framework, and to inform the development of a targeted remote prehabilitation intervention program.

Methods: This study employed purposive sampling to select 14 elderly frail lung cancer patients from a tertiary hospital in China as participants for semi-structured interviews. The data were subsequently transcribed and analyzed through qualitative inductive content analysis.

Results: The following themes and subthemes were identified. Capability: (1) experience a relatively heavy symptom burden; (2) difficulty in adjusting to negative emotions; (3) digital divide among the elderly; (4) strong ability in proactive health behaviors. Opportunity: (1) remote information-assisted support; (2) incentives based on group exercise formats; (3) a sense of belonging within a multidimensional social support network; (4) excessive concerns from family caregivers; (5) facility convenience and affordability; (6) personalized exercise plans with dynamic adjustments. Motivation: (1) perceived benefits of rehabilitation outcomes and quality of life; (2) fear of exercise induces weak exercise intention.

Conclusion: The adherence of elderly frail lung cancer patients to exercise prehabilitation under telemedicine management is influenced by three interrelated factors: capability, opportunity, and motivation. Healthcare professionals should establish a three-pronged intervention approach of "assessment-training-support". They should strengthen patients' digital technology adaptation training, design exercise programs tailored to their symptoms, and build family group support networks. In addition, psychological interventions should be emphasized to enhance patients' willingness to participate in exercise prehabilitation.

Registration Number: ChiCTR2500101145.

Keywords: lung cancer, prehabilitation, frailty, telemedicine, COM-B model, qualitative study

Introduction

Lung cancer, the second most prevalent malignant tumor, is the leading cause of cancer-related mortality globally.[1,2] In China, the burden of lung cancer is particularly severe, with both incidence and mortality rates ranking highest among all malignant tumors.[3] Although surgical resection remains the most effective treatment for early-stage lung cancer,[4,5] elderly patients frequently present with frailty syndrome, a clinical condition marked by a decline in the physiological reserves of multiple systems, which substantially elevates perioperative risks.[6,7] Epidemiological studies indicate that the prevalence of frailty among lung cancer patients can reach as high as 45%.[8] Furthermore, these patients exhibit significantly increased rates of postoperative delirium (31.2%), pulmonary infections (23.5%), and one-year mortality (7.0%), along with prolonged hospital stays.[5,9] Consequently, investigating effective perioperative intervention strategies is crucial for enhancing the prognosis of elderly frail lung cancer patients.

https://doi.org/10.2147/PPA.S600152
Received: 30 January 2026
Accepted: 23 April 2026
Published: 7 May 2026

Preoperative prehabilitation can enhance patients' physiological reserves before surgery by providing tailored nutritional support, conducting exercise training, strengthening respiratory muscles, and fostering interdisciplinary teamwork, thus boosting their surgical tolerance.[10] Exercise prehabilitation, a key element, has been shown to notably lower postoperative complication rates, reduce hospital stays, and enhance cardiopulmonary function.[11,12] Nevertheless, its clinical application encounters significant obstacles: a survey in Australia revealed that merely 16.7% of thoracic surgery patients could access prehabilitation services,[13] while a British study indicated a patient participation rate below 50%.[14] This "evidence-practice" gap may stem from the traditional face-to-face teaching model's reliance on medical resources, patients' travel challenges, and the lack of personalized intervention designs. The rapid advancement of telemedicine technology presents a promising solution to overcome these barriers by enabling remote monitoring and guidance via digital platforms, substantially improving accessibility and convenience, and ensuring intervention efficacy.[15,16]

It is worth noting that most of the existing studies focus on the objective outcome evaluation of exercise prehabilitation,[11,12] while the systematic analysis of patients' subjective experiences and participation barriers in real clinical situations is still insufficient. Especially under the telemedicine management model, the interaction methods between patients and medical staff, the information acquisition paths, and the behavioral support mechanisms have all undergone fundamental changes. The influencing factors in traditional face-to-face interventions may no longer be fully applicable. Furthermore, the participants in existing prehabilitation studies are mostly non-frail or low-risk patients.[13] However, elderly frail lung cancer patients, due to characteristics such as coexistence of multiple diseases, decreased physiological reserves, and psychological vulnerability,[6,7] face more complex challenges in the process of sports participation, and their special needs have not received sufficient attention.

Based on the above study gaps, this study adopts the COM-B theoretical framework,[17] which attributes behavioral changes to the synergy of three elements: capability, opportunity, and motivation. This framework has been widely applied in chronic disease management scenarios and is suitable for systematically analyzing the complex mechanisms influencing adherence to exercise in elderly frail patients in the telemedicine environment.[18] This study aims to explore in depth the factors influencing adherence to exercise prehabilitation in frail elderly lung cancer patients under telemedicine management through qualitative methods, with the expectation of providing a theoretical basis and practical reference for the construction of precise and scalable remote prehabilitation intervention programs.

Materials and Methods

Study Design

This descriptive qualitative study involved interviewing patients who underwent a prehabilitation program lasting 1 to 4 weeks before surgery. The individualized prehabilitation plan, determined by medical staff during the patient's visit based on their functional status, comorbidities, and preferences, was remotely implemented via the WeChat platform. While awaiting surgery at home, patients received structured exercise guidance twice a week (on Mondays and Thursdays), which included aerobic activities like home walking and stair climbing. Patients were advised to use the Borg Self-Perceived Exertion Scale to maintain exercise intensity between a Borg score of 11–14 ("light" to "slightly strenuous").[19] Additionally, resistance training (eg, using resistance bands, wall squats, and seated leg raises) and respiratory function exercises (eg, pursed-lip breathing, abdominal breathing, and breathing trainer utilization) were incorporated. Medical staff provided standardized demonstrations of each exercise session using text, images, short videos, and voice messages. Patients were encouraged to daily document their exercise regimen through text, voice recordings, or photos and share them with the WeChat management group.

Medical staff provided at least two centralized responses to patients' exercise feedback each week and proactively follow up with patients who do not provide feedback or have incomplete feedback. For those who experience increased pain, fatigue, or emotional distress, the intensity or content of the plan shall be adjusted after consultation between the nurse and the rehabilitation physician. The adherence of patients with exercise prehabilitation is evaluated based on the degree of match between the training completion status reported by the patients and the goals set in the program. During

their hospitalization, patients receive face-to-face guidance from medical staff to ensure the standardization and safety of their movements.

Participants

This study selected representative patients based on gender, age, educational level, monthly family income, place of residence, marital status, degree of frailty, and comorbidities. Employing a purposive sampling method, patients who visited the thoracic surgery department of a tertiary hospital in Shandong Province from May 2025 to July 2025 were included. The inclusion criteria were as follows: (1) Patients must have a pathological diagnosis of primary lung cancer; (2) Age must be between 60 and 80 years; (3) The frailty phenotype scale score must be ≥1 point (Fried score 1–2: pre-frail; ≥3: frail);[20] (4) Patients must possess the capacity to act and be willing to participate in the interview; (5) Patients must be capable of using a smartphone. The exclusion criteria included: (1) Patients with mental illness or cognitive impairment; (2) Patients suffering from severe diseases of vital organs, including but not limited to heart failure, stroke, or acute exacerbation of chronic obstructive pulmonary disease. The sample size adhered to the principle of data saturation, as no new thematic insights emerged during three consecutive interviews (participants 12, 13, and 14). All identified topics were thoroughly developed and detailed. Two researchers independently verified this finding and confirmed that no further interviews were necessary.

Data Collection

This study gathered data through in-person, semistructured, in-depth interviews consisting of two components. The first component involved collecting relevant sociodemographic and clinical information from the patients, along with their completion of the frailty phenotype scale. The second component entailed the formulation of open-ended interview questions based on a literature review, expert consultation, and the COM-B theory. Preinterviews were conducted with three patients to refine the interview content. The interview outline was then supplemented and revised, and the final version is presented in Figure 1. Before the study began, the purpose, significance, and confidentiality principles were explained to the patients. After obtaining informed consent, the interviews were recorded. The first author, who had qualitative study experience, conducted all interviews. Patients participated in individual interviews in a quiet office setting one day before their surgery, with each interview lasting between 7 and 21 minutes.

Although the interview duration for this study was relatively brief, the depth of the interviews was ensured through several strategies. These included familiarizing the interviewers with the materials prior to the interviews, adjusting the interview sequence based on the actual circumstances during the discussions, and encouraging patients to articulate their

COM-B Model	Interview questions
Capability	1.Could you describe the situation of the daily prehabilitation exercise? If you fail to complete the prehabilitation plan for the day, how do you handle it? 2.In this prehabilitation program, what kind of help and support do you think you are still lacking?
Opportunity	3.What are your impressions of the prehabilitation exercise program in terms of ease of implementation? 4.What factors or conditions influence your decision to engage in the prehabilitation program? 5.What factors or conditions impede your participation in the prehabilitation program, and have any solutions been identified? 6.Additionally, what has been your experience with utilizing telemedicine services for this purpose?
Motivation	7.What kind of help have you received during your exercise? 8.How do you feel during the process of exercising? 9.Do you have anything else to add about exercise prehabilitation?

Figure 1 Interview questions.

https://doi.org/10.2147/PPA.S600152

genuine thoughts. Additionally, necessary inquiries were made, and responses were retold and summarized to reflect the patients' content accurately. Observations and recordings of the patients' actions and expressions further contributed to the richness of the data collected. This study adhered to the COREQ reporting guidelines,[21] see Supplementary File 1 for details. The interviewees comprised thoracic surgery nurses (first author) who had a potential clinical care relationship with the participants. Prior to the interviews, it was explicitly communicated to the patients that the content of the interviews was solely for research purposes and was unrelated to clinical treatment or surgical arrangements. Deviations were controlled through the use of open outlines, independent coding, and a two-person review process. An independent interview space was selected, and it was emphasized that there were no right or wrong answers. Social expectation deviations were minimized through behavioral verification and the validation of feedback records.

Data Analysis

Within 24 hours of the interview, the interviewer transcribed the recording into text. To ensure the authenticity of the materials, the researcher verified the content with the interviewee. After confirming the absence of errors, the analysis and extraction proceeded. The analysis and refinement were conducted using Nvivo 11.0 software. Two researchers independently analyzed the data, and any discrepancies were resolved through joint discussion within the study group.

This study is based on the framework of the COM-B theory and adopts the directed content analysis method. The specific steps are as follows: (1) Extract the statements related to the exercise prehabilitation behavior of elderly frail lung cancer patients from the interview data to form the basic analysis unit; (2) Formulate the classification outline based on the COM-B theoretical framework and determine the categories of the analysis units; (3) Read the content of the materials repeatedly, code the materials with important concepts, and categorize the relevant codes under the corresponding themes and sub-themes. (4) Establish the connection between the results of data analysis and the original data, and select representative excerpts from the data as examples. To enhance the credibility and accuracy of data analysis, two researchers independently completed the coding and classification. In case of any disagreement, the study team reached an agreement through joint discussion.

Ethics

This study was conducted in accordance with the Declaration of Helsinki and approved by the Medical Ethics Committee of Qingdao Municipal Hospital (No. 2025-KY013-019). Written informed consent was obtained from all interviewees before the formal interview, including the publication of anonymized responses.

Results

General Information of Participants

Sixteen patients were initially invited to participate in the study, but two declined due to their unwillingness to undergo surgery, resulting in a final participation of 14 patients. The average age of the participants was 73.1±4.3 years. Among them, 11 were married and 3 were widowed. 6 resided in rural areas, while 8 lived in urban settings. Educational backgrounds varied, with 5 having completed primary school or below, 6 with middle and high school education, and 3 holding a university degree or above. Ten patients were classified as pre-frail (Fried score 1–2), while four were categorized as frail (Fried score ≥3). The average duration of prehabilitation was 2.8±1.0 weeks. Further details on participant characteristics can be found in Table 1. The study identified three main themes and 12 corresponding sub-themes, as outlined in Table 2.

Capability

Experience a Relatively Heavy Symptom Burden

Patients with lung cancer accompanied by frailty often have multiple chronic diseases, reduced activity endurance, and symptoms such as fatigue and pain, which increase the burden of prehabilitation through exercise for the patients.

P1: "When climbing stairs, I get very tired after climbing a few floors. I can climb slowly and it will not take long".

Pain not only restricts the way of exercising but also weakens the patient's confidence in exercise.

Table 1 Patient Characteristics (n=14)

Number	Gender	Age	Education	Annual Household Income (RMB10,000)	Place of Permanent Residence	Marital Status	Duration of Prerehabilitation for Exercise (Weeks)	Frailty Score	Complications
P1	Male	76	Primary school and below	≥1	Rural	Married	2	1	a,b
P2	Female	71	Middle and high school	0.5~1	Urban	Married	3	2	b
P3	Male	68	Primary school and below	≥1	Urban	Married	4	1	a,b,c
P4	Male	78	University and above	≤0.5	Rural	Widowed	3	4	a,c
P5	Female	71	University and above	≥1	Urban	Widowed	2	1	b
P6	Male	67	Primary school and below	0.5~1	Rural	Married	3	1	a,b
P7	Female	77	Middle and high school	0.5~1	Urban	Married	2	3	a,b,c
P8	Female	80	Primary school and below	0.5~1	Rural	Married	2	2	b,c
P9	Male	76	Middle and high school	0.5~1	Urban	Married	1	1	b
P10	Male	76	Middle and high school	≥1	Urban	Married	4	2	a,b
P11	Female	77	Middle and high school	0.5~1	Urban	Married	4	3	a,b
P12	Female	66	University and above	≥1	Urban	Married	4	1	b,d
P13	Female	71	Primary school and below	≥1	Rural	Widowed	3	2	a,b
P14	Male	77	Middle and high school	0.5~1	Rural	Married	2	3	a

Notes: a: High blood pressure; b:Diabetes; c:Chronic obstructive pulmonary disease; d:Obesity.

Table 2 Themes and Subthemes

Themes	Sub-Themes
Capability	Experience a relatively heavy symptom burden Difficulty in adjusting to negative emotions Digital divide among the elderly Strong ability in proactive health behaviors
Opportunity	Remote information assisted support Incentives based on group exercise formats A sense of belonging within a multidimensional social support network Excessive concerns from family caregivers Facility convenience and affordability Personalized exercise plans with dynamic adjustments
Motivation	Perceived benefits of rehabilitation outcomes and quality of life Fear of exercise induces weak exercise intention

P5: "My back is always hurt, so I do not do any exercises that strain my waist".

P10: "The difficulty is that we cannot run quickly by ourselves. You still have to run it slowly. It took only 10 minutes to get there, but now it takes 20 minutes".

https://doi.org/10.2147/PPA.S600152

Difficulty in Adjusting to Negative Emotions

Due to the uncertainty and risks of the surgery, patients often feel negative emotions such as stress, anxiety, and sadness before the operation and have difficulty adjusting themselves. This can easily induce sleep disorders, aggravate frailty symptoms, and further hinder exercise prehabilitation.

P4: "Now, my children have all moved out, and I am living alone. Sometimes, when I think of this illness at night, I cannot sleep. During my day, I am all asleep. After a while of the activity, I feel very tired and have no energy to exercise".

The worry about family ties can turn into physical weakness and behavioral withdrawal.

P7: "I'm so worried. I am afraid that the operation will not be done well, and I will add more burden to my children. I feel very weak and do not want to move".

Digital Divide Among the Elderly

The digital divide among the elderly pertains to the challenges faced by older adults in effectively utilizing digital technologies to access resource services. This difficulty arises from their limited skills with devices and applications, coupled with constraints in their learning abilities.[22]

P3: "Most of the time I use my phone, I am on my child's phone and watch videos".

Digital technology support from children effectively enhances the digital operation skills of elderly patients, promoting their shift from passive dependence to autonomous use of telemedicine resources.

P7: "My daughter came back and helped me download that rehabilitation software. She also taught me step by step how to use it. She pointed out each button to me one by one and asked me to operate it repeatedly several times. Later, I was able to open the video and practice along by myself".

The differences in information reception preferences have further exacerbated the digital divide.

P13: "I can only type it by hand. I am not used to reading text on my phone. I would rather talk to the doctor face-to-face".

Strong Ability in Proactive Health Behaviors

High level active health behavior ability can, to a certain extent, enhance patients' subjective initiative and promote their active participation in exercise prehabilitation.

P5: "After being diagnosed with lung cancer, the doctor asked me to do preoperative exercise rehabilitation. I said, 'I'm good at this. I think your body belongs to you. If you don't take the initiative to manage it yourself, no one else can do it for you".

The long-term habit of active exercise is a favorable condition for prehabilitation through exercise.

P2: "When I got old, I felt that exercising was important. I exercised for an hour every day".
P12: "I really enjoy going out for my activities. When we go out for activities, it is always me who organizes them".

Opportunity

Remote Information-Assisted Support

Most patients reported that telemedicine provided them with accurate and comprehensive information regarding exercise prehabilitation, thereby fulfilling their preoperative informational needs and enhancing their understanding of the significance of exercise prehabilitation.

P10: "After confirming the surgery, I also looked up some information. The information you sent was too useful".
P12: "My house is very far from the hospital, so it is inconvenient. Your one is very good. If there is a problem, I can contact the doctor through WeChat".
P14: "This information is very good (nodding). I watch videos every day and practice (respiratory function exercises). This video was quite simple. I can watch it once".

Incentives Based on Group Exercise Formats

Organizing exercise in the form of groups can increase the sense of social connection and interest in the exercise behavior of the elderly and encourage patients to adhere to exercise prehabilitation.

P2: "Before, it was square dancing because I had a few friends who love to dance. We often dance together".
P6: "I just made an agreement with those few friends that we would go for a walk in the park together every afternoon. Everyone chatted as they walked. An hour passed quickly, and they didn't feel tired at all".
P12: "I have few friends. We have a Group chat. Every afternoon, we swim together at sea".

When there is a lack of group support, it is difficult for patients to maintain their intention to exercise.

P11: "It would be nice if I had someone to keep me. The main problem is that I do not have anyone to exercise".

A Sense of Belonging Within a Multidimensional Social Support Network

Recognition, understanding, and encouragement from family, friends, and other parties can enable the elderly to find a sense of identity and belonging, narrow the distance between patients and social groups, and promote their active participation in prehabilitation exercise.

P2: "Sometimes, I have an appointment with some friends to exercise together, and I feel embarrassed not to go".

Urging support drives patients to transform their intention to exercise into actual behavior through continuous external stimuli.

P6: "My wife runs with me, she does it with me".
P8: "My son downloaded a check-in app for me. He gives me likes every night and I keep doing it every day".
P13: "The children know you want me to exercise, and they remind me every day not to forget to do it".

Excessive Concerns from Family Caregivers

Family caregivers are overalert to exercise participation, fearing injury during exercise, which hinders exercise prehabilitation.

P5: "When I went out to exercise, the children told me not to go out, afraid that I would come back sweating and catch cold".
P14: "I fell once after taking a shower. My child was afraid that I would accidentally fall down again, so he did not let me go".

Facility Convenience and Affordability

According to the living environment of patients, medical staff provide personalized exercise prehabilitation facilities and places for patients, which can help them perform exercise prehabilitation.

P9: "At home, I will blow balloons and practice deep breathing as the doctor says, and then walk and run every day. When I get to the hospital, there is exercise equipment in the recovery room, so I will do what you say".
P12: "Even if the weather is bad, I can climb stairs, as the doctor says".
P13: "There's that kind of fitness equipment in the community. I walk around it twice a day. It's free and I can also enjoy the sun. It's great".

Personalized Exercise Plans with Dynamic Adjustments

The patients indicated that the main motivation for participating in exercise prehabilitation was the professional and personalized exercise prescription formulated by medical staff to meet their physical ability and feedback and supervision during the implementation process.

P6: "You have taught me how to perform these exercises. At that time, because I did not know how much exercise I had done, I sent you a WeChat message, and I understood".
P7: "At that time, I saw that my heart rate was very fast on my sports watch, so I did not dare to exercise anymore. You helped me to adjust it, and I was relieved".
P11: "I will do it according to the video you have sent. It's pretty simple".

Motivation

Perceived Benefits of Rehabilitation Outcomes and Quality of Life

Patients perceived that exercise prehabilitation had certain benefits for postoperative functional rehabilitation and improved quality of life, which affected their health beliefs and thus their behavioral changes.

P2: "I exercise daily. After the operation, I will recover my previous living standards as soon as possible".
P10: "My wife is not in good health either. I have to get well quickly to take care of her. Exercise is definitely useful. I believe that. If we practice well, both of us will suffer less".
P14: "I just hope I can still play chess and take a walk with my old buddies after the surgery. I practice every day now".

Health information transmission can enhance the perception of benefits and thereby increase the willingness to change behavior.

P9: "I did not know this before. After you told me, I think I needed to do this well. I hope that I can recover better".

Fear of Exercise Induces Weak Exercise Intention

Some patients show a previous experience of sports injuries, and their reduced mobility makes them have negative judgments on exercise ability, and their intention to exercise becomes weak.

P7: "I broke a bone once before and now I am afraid to exercise".
P11: "Sometimes I encounter a higher slope and I dare not climb up".

Discussion

Utilizing the COM-B theoretical framework, this study systematically examined the factors that influence exercise adherence during prehabilitation in elderly frail lung cancer patients receiving telemedicine management. The study identified three primary findings: First, within the capability dimension, the physiological-psychological negative feedback loop and the stratification of the digital divide emerge as significant barriers. Second, regarding the opportunity dimension, social networks exhibit a dual role, with patients demonstrating a greater inclination to utilize home-accessible sports facilities under remote management. Third, in the motivation dimension, fear of movement results in a "separation of knowledge and action", while expectations regarding rehabilitation outcomes serve as a motivating factor. The following discussion will elaborate on these three dimensions.

Capability Dimension: This study identified that elderly frail patients face three significant challenges: a decline in physiological function, difficulties in emotional regulation, and the digital divide. Physiologically, these patients frequently experience multiple chronic diseases. In this study, 71.4% of participants reported having two or more chronic conditions, leading to the coexistence of various symptoms, including fatigue, pain, and shortness of breath. These findings align with results from multiple studies, indicating that such somatic symptoms directly limit patients' exercise tolerance and intensity.[23,24] Additionally, this study revealed that negative emotions can exacerbate the decline in physiological functions, while physical symptoms further impair emotional regulation. Research indicates that 48.4% of lung cancer patients experience high anxiety prior to surgery.[25] Interviews conducted in this study revealed that respondents expressed significant concerns regarding family ties, alongside dual anxieties about surgical risks and rehabilitation outcomes. These factors contribute to sleep disorders among patients, which subsequently diminish their willingness to engage in physical activity, thereby creating a psycho-physiological negative feedback loop. While previous studies have suggested that the need for preoperative psychological intervention for lung cancer patients is limited,[26] this study found that frail patients generally struggle to manage negative emotions, corroborating the conclusions of numerous studies.[27] This implies that frailty serves as a screening indicator for psychological intervention. The interplay between physiology and psychology underscores the need for healthcare providers to conduct a thorough evaluation of the patient's symptom burden, introduce exercise regimens tailored to specific symptoms, and devise customized training protocols focusing on the primary symptoms. Emphasizing the preoperative psychological evaluation of elderly lung cancer patients with frailty can offer valuable preoperative insights, foster trust between doctors and patients, and aid in alleviating negative emotions.

This study found that under telemedicine management, there is a significant digital divide phenomenon among patients. Patients with high digital literacy can fully utilize the convenience of technology to obtain sufficient information on exercise prehabilitation and promote their participation in exercise prehabilitation, while those with low literacy are hindered as a result. This is consistent with the study results of Kerstiens et al[28] In addition, patients have different preferences for information reception. Compared with simple textual guidance, some patients prefer traditional face-to-face communication. In this study, the patient's account mentioned the role of "intergenerational technical support". Intergenerational technical support refers to the assistance and skill transfer provided by the younger generation to the elderly in areas such as operating digital devices, using applications, and solving technical problems.[29] This kind of support lowers the technical entry threshold for elderly patients and enhances their sense of self-efficacy in using telemedicine services. This suggests that under telemedicine management, merely providing a digital information platform may not be sufficient to serve all elderly patients. Technical assistance at the intergenerational or community level may enhance the digital literacy of elderly patients. Medical staff should attach importance to digital skills training for patients before intervention and provide them with intuitive, specific, and visualized exercise guidance to ensure the continuous implementation of the intervention.

Opportunity dimension: This study found that social network support plays a dual role. On the positive side, the family-group collaborative participation model can promote mutual communication among patients, help them get rid of the feeling of loneliness, and enhance the external driving force for behavioral changes in patients' exercise prehabilitation,[30,31] which is consistent with the study results of Maula et al[32] In addition, this study found that patients who prefer team sports show higher active health behavior ability and adherence to prehabilitation. However, on the negative side, family caregivers, overly concerned about the patient's physical condition, prevent the patient from participating in exercise rehabilitation, which reflects the conflict between traditional care concepts and modern rehabilitation ideas. Medical staff can conduct systematic health education for the family members of patients to enhance their understanding of the safety and necessity of prehabilitation through exercise, thereby adjusting the excessive risk perception under the traditional care concept and encouraging family members to form supportive behaviors that are in line with the rehabilitation goals.

In contrast to the findings of Barnes et al,[33] this study revealed that elderly and frail lung cancer patients are more likely to utilize accessible home exercise resources, such as balloon blowing and stair climbing, when managed through telemedicine Additionally, the study indicated that incorporating everyday items, such as chairs and resistance bands, into exercise interventions can significantly enhance patient adherence.[34] These results suggest that medical professionals should minimize their dependence on specialized equipment when developing exercise plans. Instead, they should consider the patients' actual living environments, daily activity levels, and treatment preferences, thereby offering personalized exercise prehabilitation facilities and locations tailored to individual needs.

Motivation dimension: This study found that exercise fear hinders patients from undergoing exercise prehabilitation. Although patients generally recognize the importance of exercise prehabilitation, the exercise fear psychology leads to the phenomenon of knowledge-action separation, which is consistent with the research of Wang et al[35] This kind of fear stems from patients' multi-dimensional misassessment of the risks of exercise, including overestimating the possibility of sports injuries, underestimating their own tolerance, and underestimating the professional protection of medical staff, thus forming a fear-avoidance behavioral pattern, which hinders the transformation of exercise intentions into actual behaviors. Medical staff should accurately assess the exercise risks of patients, adjust the exercise intensity in a personalized manner, help patients establish a correct understanding of their physical abilities, and promote their prehabilitation through exercise.

Conversely, the anticipated rehabilitation outcome, as a positive psychological factor, can significantly influence participation in sports. This study revealed that patients place considerable importance on postoperative functional recovery and improvements in quality of life, aligning with the findings of the "expected benefit-behavioral incentive" framework identified in the colorectal cancer prehabilitation study.[26] It is recommended that medical professionals enhance patients' understanding of the value of prehabilitation through exercise, assist them in establishing personalized and specific rehabilitation goals, and thereby bolster their intrinsic motivation for engaging in prehabilitation activities.

This study not only confirmed the applicability of the COM-B model in the context of exercise prehabilitation for elderly frail lung cancer patients but also elucidated the behavioral characteristics of this population under telemedicine management. This finding expands the explanatory scope of the model within the dual contexts of telemedicine and frail elderly individuals. Specifically, physical symptoms and negative emotions interact to create a cyclical relationship rather than functioning independently. Although telemedicine has improved information accessibility, it has disproportionately benefited patients with strong digital skills, while those with weaker capabilities have encountered greater challenges in keeping pace. The introduction of technology has exacerbated the disparity in capabilities. Family support can serve a dual role, either facilitating progress through companionship and supervision or hindering it due to excessive concern. Concurrently, patients tend to utilize readily available home resources, such as inflating balloons and climbing stairs, rather than relying on professional facilities. This behavior suggests that "physical opportunities" are more dependent on real-life circumstances than on the availability of specialized equipment.

Limitations

In this study, patients received 1 to 4 weeks of prehabilitation. The difference in duration may affect motivation maintenance (short-term patients' intentions were not solidified), perceived benefits (long-term patients were more likely to report functional improvements), and adherence experience (those with low digital literacy required a longer adaptation period). Although the themes of participants of different durations did not show stratified differences, readers should take this background into account when interpreting the results. It is suggested that future research could adopt a fixed-duration design or longitudinal tracking to clarify the dynamic impact of intervention duration on motivation maintenance, perceived benefits, and adherence experience. This study was only conducted in a single hospital in China, with a limited sample size. It also did not cover universal issues among other ethnic groups, which restricted a comprehensive analysis of the influencing factors of prehabilitation through exercise. Furthermore, the inclusion criteria of this study required "the ability to use a smartphone", which prevented patients with no digital skills at all from being included. This suggests that the research results are mainly applicable to elderly patients with basic digital skills, and there are certain limitations in promoting them to people with extremely low digital literacy. Moreover, this study only conducted interviews with patients and lacked the perspective of medical staff. Future research can further explore the influencing factors of exercise prehabilitation in elderly lung cancer patients through multi-center design, incorporating the perspectives of medical staff and different ethnic groups, and relaxing the inclusion restrictions of digital capabilities.

Conclusion

The exercise prehabilitation behavior of elderly frail lung cancer patients is influenced by a complex interplay of physiological, psychological, technical, and social factors. While telemedicine management has improved service accessibility, it has also introduced challenges for digitally disadvantaged groups. Future interventions should prioritize personalized assessment, intergenerational technical assistance, and collaborative family involvement to address the digital gap, disrupt negative feedback cycles, and ultimately boost participation and rehabilitation outcomes in exercise prehabilitation.

Abbreviations

COM-B, Capability, Opportunity, Motivation and Behavior.

Data Sharing Statement

The data supporting this study have been de-identified and are available upon reasonable request from the corresponding author, Yu-Rong Ma.

Acknowledgments

The authors thank all lung cancer patients who participated in this interview and the nursing staff for their assistance with data collection.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

Shandong Provincial Natural Science Foundation Youth Project "Research on the Theory and Practice of Industry-Finance Integration in Public Hospitals from the Perspective of New Productivity" (ZR2024QG200). The funders had no role in the study design, collection, analysis, interpretation of data, writing of the report, or decision to submit the article for publication.

Disclosure

The authors report no conflicts of interest in this work.

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