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Abstract

Background: Postoperative lung cancer patients often experience frequent symptoms, multisystem dysfunction, reduced physical strength and activity levels, significantly impacting their quality of life. Continuity of care is crucial for these patients. Information technology based on patient-reported outcomes can efficiently assess symptoms and improve health.

Objective: This study aims to determine the impact of a personalized follow-up program based on patient-reported outcomes on the quality of life and self-management efficacy of postoperative lung cancer patients, and to explore their compliance and perspectives on its use.

Methods: A parallel-arm randomized controlled trial with an assessor-blinded design and repeated measures.Participants were recruited from the inpatient oncology department of a university-affiliated hospital in Shanghai, China. A total of 240 lung cancer patients who had undergone radical lung cancer surgery and were discharged participated in the postoperative follow-up study.Participants were randomly assigned to either the experimental or the control groups. Patients in the experimental group received a personalized follow-up program based on patient-reported outcomes. This program incorporated the MD Anderson Symptom Inventory with set alarm thresholds, enabling nurses, supported by a multidisciplinary team, to accurately assess and identify individual needs and provide tailored interventions. The control group received only the usual telephone follow-up. Baseline data (T0) were collected before the intervention (on the day of discharge), and quality of life, self-efficacy, and compliance were measured at 2 weeks (T1), 4 weeks (T2), and 12 weeks (T3) post-discharge. Additionally, patients in the experimental group were asked to share their experiences and perspectives on the intervention through open-ended questions.

Results: The difference in quality of life between the experimental and control groups was significant (Wald X^2=5.204, P=.023), with the experimental group showing significantly better quality of life at T2 compared to the control group (t=2.515, P=.013). No significant differences were observed at T0, T1, and T3. Both groups showed improvements in quality of life at all post-test time points (Wald X^2=574.167, P < .001), and the interaction between group and time was not statistically significant (Wald X^2=2.354, P=.308). Regarding self-management efficacy, Generalized Estimating Equations results indicated a significant difference between the experimental and control groups (Wald X^2=6.573, P=.010), with the experimental group showing significantly higher self-management efficacy at T2 and T3 compared to the control group (t=3.024, P=.003; t=2.214, P=.028). No significant differences were observed at T0 and T1. Both groups showed improvements in self-management efficacy at all post-test time points (Wald X^2=301.390, P < .001), and the interaction between group and time was not statistically significant (Wald X^2=3.971, P=.137). A thematic analysis of the experimental group's feedback on device usage revealed six major categories.

Conclusions: This study shows that for patients after lung cancer surgery, it is appropriate, acceptable, feasible and attractive to rely on WeChat mini-programs to carry out follow-up projects based on patient-reported outcomes. This program has improved the postoperative quality of life and self-management efficacy of lung cancer patients. Evidence transformation, staff training, patient-reported outcome tool setting, and multidisciplinary cooperation are effective strategies to ensure implementation.

Clinical Trial: Registered in ClinicalTrial.gov on 13 March 2024(NCT06483295), began recruiting participants subjects on 14 March, 2024.

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Abstract

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Keywords: Lung neoplasm; postoperative period; patient-reported outcome; follow-up; quality of life; self-management efficacy

Introduction

Lung cancer is the most prevalent type of cancer globally, with both the incidence and mortality rates ranking highest among all cancers[1]. Surgical resection remains the preferred curative treatment for lung cancer. The Enhanced Recovery After Surgery (ERAS) pathway reduces postoperative hospital stay for lung cancer patients; however, it also results in patients often being discharged during the early or middle stages of recovery rather than the late stages. Invasive surgical trauma[2-4] leads to a significant decline in exercise tolerance within the first-week post-surgery, lung function and physical performance within two weeks, and daily activity levels within four weeks compared to preoperative levels[5-8]. The incidence of various symptoms ranges from 48% to 79%[9, 10], and it can take 1 to 3 months or longer to return to preoperative normal activity levels[11-13], profoundly impacting quality of life[2]. Therefore, postoperative continuity of care is crucial, challenging the medical team's ability to make efficient and precise diagnostic and intervention decisions within a limited time frame[14].

The widespread use of smartphones has facilitated the emergence of follow-up methods based on patient-reported data[15]. These methods enable immediate and convenient remote monitoring of postoperative symptoms, providing a solid foundation for dynamically adjusting treatment strategies[16] and accelerating patient recovery[17]. Research by Tang et al. [18] and Dai et al. [19] has highlighted the potential of information technology based on patient-reported outcomes to alleviate the symptom burden in lung cancer patients. This technology has been shown to enable efficient and regular symptom assessment in busy clinical environments, leading to substantial improvements in patient health and well-being [20].

Currently, related studies primarily employ longitudinal designs to evaluate the feasibility[18] and acceptability[18] of the tools, survival rates[21], compliance[22], symptom trajectory changes[22], cost-effectiveness[23], and tumor recurrence monitoring[24]. A limitation of these studies is the lack of a routine care group without monitoring for comparative analysis[20] or the use of retrospective data as a control group[21]. Only three randomized controlled trials exist[19, 20, 25], and the actual impact on patients' quality of life and self-management efficacy remains

unclear, failing to provide a comprehensive view of the effectiveness of continuity of care in postoperative patients. One clinical trial only used patient-reported outcomes (PROs) to assess the incidence of symptom threshold events[20]. This could affect the comprehensiveness and generalizability of the results, offering limited guidance for clinical practice and research.

Information technology based on patient-reported outcomes holds promise as a key strategy for identifying and managing actionable symptoms, thereby optimizing the overall health of lung cancer patients. It also reminds us that future research should be dedicated to building a more comprehensive and extensive patient reporting framework to fully test the actual effectiveness of mobile health technology in multi-symptom and multi-dimensional assessment[26]. To this end, our research team developed a personalized follow-up program for lung cancer patients based on patient-reported outcomes using a WeChat mini-program. This program enables nurse-led teams to conduct online and offline interactive interventions. We initially investigated its effects on the quality of life and self-management efficacy of lung cancer patients at 2 weeks, 4 weeks, and 12 weeks post-surgery, as well as the experimental group's compliance and perceptions of the system. This was accomplished through a randomized controlled trial.

Method

Study design and setting

This study is a single-center, prospective, single-blind (assessor-blinded), randomized controlled trial. The trial has been registered in ClinicalTrial.gov (registration number: NCT06483295) and has received approval from the Ethics Committee of Shanghai Chest Hospital (Project No. IS22099).

participants

Recruitment was conducted in the fourth ward of the Oncology Surgery Department at Shanghai Chest Hospital, which performs over 12,000 thoracic surgeries annually. This ward has 51 beds and an average of over 2,700 lung cancer surgeries per year. Participant recruitment began on 14 March 2024, with the study commencing on 13 March 2024. All research plans and data collection were completed on 7 July 2024, following the three-month follow-up of the last discharged patient.

The inclusion criteria for patients were: (1) Diagnosed with non-small cell lung cancer without distant metastasis or other tumors and undergoing surgery with curative intent; (2) Aged 18 years or older; (3) Informed about their disease diagnosis and treatment; (4) Able to express themselves; and (5) Able to read and write using a smartphone. The exclusion criteria for patients were: (1) Cognitive impairments (understanding or expressing themselves); (2) History of being intolerant to surgery or having severe complications; (3) Presence of psychiatric disorders or cognitive impairments; and (4) Participation in another intervention study.

Sample size

Based on the sample size calculation for comparing the means of two independent samples, using the quality of life scale score as the primary outcome measure, and referring to the study results of Sommer et al.[27], the post-intervention scores were (102.0 ± 21.2) for the control group and (110.2 ± 15.6) for the experimental group. Using PASS 15.0 software, with $\alpha = 0.05$, $\beta = 0.8$, and a two-sided test, it was calculated that each group would need 82 participants. Adding 20% for potential dropouts (21 participants per group), the final estimated sample size

was 206, with 103 participants in each group. In our actual study, we ultimately recruited 266 patients.

Randomization, concealment, and blinding

Research Assistant A assessed the eligibility of participants, obtained written informed consent, and collected baseline data. Research Assistant B, who was not involved in the recruitment process, performed the random allocation using a random sequence set generated from the research randomizer website (https://www.randomizer.org/). The numeric sequence consisted of 240 unique numbers. Research Assistant A randomly assigned consenting participants who completed the baseline assessment to either the experimental or control groups in a 1:1 ratio, based on their enrollment order and the random codes on the envelopes. Due to the nature of the interventions in this study, blinding of the participants and the nursing researchers (QW) implementing the interventions was not possible. However, the recruiter (Research Assistant A) was unaware of the group assignments.

Intervention

Firstly, we conducted a scoping review to clarify the use of mobile information platforms based on patient-reported outcomes in studies involving discharged lung cancer patients. This review encompassed patient-reported content, patient-reported outcomes tools (including threshold settings), and data collection timing. We found only two studies utilizing randomized controlled trials, with one focusing exclusively on advanced lung cancer patients. Subsequently, we conducted semi-structured interviews with 27 stakeholders, including 9 thoracic surgery healthcare providers (2 doctors and 7 nurses), and 9 lung cancer patients and caregivers, to identify implementation facilitators and barriers.

Based on the evidence and stakeholder inputs, we drafted an initial plan and invited feedback from 16 experts, including surgeons, clinical nursing experts, nursing managers, nursing educators, and evidence-based methodologists. The final plan was revised and refined according to their feedback. We identified four implementation strategies for personalized follow-up projects for lung cancer patients based on patient-reported outcomes: evidence transformation, multidisciplinary cooperation, team formation and training, and patient-reported outcome tool settings (application ports and functions). Detailed intervention content is provided in Multimedia Appendix 2.

In this project, we selected and integrated the MD Anderson Symptom Inventory (MDASI) [28] as the built-in patient-reported outcome tool within the mini-program. Additionally, we incorporated a lung cancer-specific assessment module to provide more precise health monitoring services. However, the lung cancer assessment module developed by the MD Anderson Symptom Center focuses on only three symptoms: cough, constipation, and sore throat. Based on past research data and our team's extensive clinical experience, we found that these indicators do not fully cover the typical symptom manifestations of lung cancer patients in China. Therefore, to better meet the actual needs of Chinese patients, we combined the lung cancer-specific symptom module designed by Wang et al.[29] with the MD Anderson Symptom Inventory, resulting in a more comprehensive and targeted assessment system.

In the WeChat mini-program-based lung cancer follow-up project, patients first register and log into the WeChat mini-program. They receive regular reminders to complete the MD Anderson Symptom Inventory (MDASI) and submit their reports. Patients are prompted to report twice

weekly for the first month post-discharge, then once weekly until three months post-discharge, or as needed based on their symptom perception. Surveys are sent three times a day at each time point until the patient responds[22]. Patients can view historical records, access health education content, provide feedback on their usage, and consult for any questions they might have. Healthcare providers log into the WeChat mini-program to review the symptom reports submitted by patients, paying particular attention to reports exceeding threshold values. They record and implement intervention measures as necessary. Additionally, healthcare providers manage patient information and report data, conduct statistical analyses and trend analysis, and communicate with patients to answer their questions and provide recommendations. Based on individualized symptom assessment, nurses implemented personalized education plans for each participant according to the patient-reported data. [see Multimedia Appendix 2 and Multimedia Appendix 3]

Usual care

Participants in the control group received standard care including brief guidance from thoracic surgery nurses. The main components of the guidance were: (1) Breathing Function Training: Continue daily breathing exercises after discharge. (2) Exercise Rehabilitation Training: Perform daily arm-lifting exercises on the surgical side and engage in moderate aerobic activities such as walking and Tai Chi. Gradually increase activity levels to avoid fatigue. Refrain from lifting heavy objects or engaging in strenuous physical labor within three months post-surgery. (3) Monitoring and Self-Management of Common Postoperative Symptoms: Monitor for symptoms such as elevated temperature, dry cough, and pain. (4) Wound Care: Keep the wound clean and dry. (5) Lifestyle Adjustments: Abstain from smoking and alcohol. Follow a diet high in calories, protein, and vitamins, but low in salt and fat. Avoid spicy foods, coffee, and strong tea. Follow-up instructions for the first month after discharge were also provided.

Standard care was provided by the same nursing team as the intervention group. Additionally, participants received a monthly phone call for three months and an educational booklet during their outpatient follow-up at the end of the study (three months post-surgery) to adhere to research ethics.

Measures

Personal Information Questionnaire

The evaluation utilized a self-designed questionnaire to gather comprehensive patient information and basic disease data. General information encompassed patient demographics such as gender, age, BMI, education level, marital and employment status, place of residence, and monthly household income per capita. Basic disease details included whether patients underwent postoperative chemotherapy or radiotherapy, tumor type, surgical approach, type of surgery, tumor stage, preoperative lung function, comorbid chronic diseases, duration of chest tube placement, postoperative hospital stay, and total hospitalization duration. Data were retrieved from patients' medical records.

Functional Assessment of Cancer Therapy Lung Cancer, FACT-L

Developed by Cella et al. [30] and translated into Chinese by Wan et al.[31], this scale comprises a general module for assessing cancer therapy's functional impact and a lung cancer-specific module tailored to evaluate the quality of life among lung cancer patients. The scale covers five dimensions: physical well-being, social/family well-being, functional well-being, emotional well-being, and additional concerns, totaling 36 items. Responses are recorded on a 5-point Likert scale, with positively worded items ranging from 0 (not at all) to 4 (very much), and

negatively worded items reverse-scored. Scores range from 0 to 144, with higher scores indicating better quality of life. The scale's internal consistency, measured by Cronbach's α coefficient, was validated at 0.805.

Strategies Used by People to Promote Health, SUPPH

Developed by Lev et al. [32] and translated into Chinese by Qian et al. [33], this scale demonstrates robust reliability and validity. It comprises three dimensions: self-decompression, self-decision making, and positive attitude, encompassing a total of 28 items. Responses are recorded on a 5-point Likert scale, ranging from "not confident at all" to "very confident," scored from 1 to 5. The total score, ranging from 28 to 140, reflects the overall confidence level of postoperative lung cancer patients in managing their disease, with higher scores indicating greater confidence. The scale exhibits a Cronbach's α coefficient of 0.970, with coefficients for each dimension ranging from 0.849 to 0.959.

Adherence to the Study Intervention

Patient compliance with the study intervention was assessed in terms of frequency and percentage. In addition, participants from the experimental group were invited to articulate their experiences and perspectives on the intervention through open-ended questions. We employed traditional qualitative content analysis to transcribe and analyze their responses. Initially, transcripts were carefully reviewed multiple times to identify open codes. Subsequently, we organized subcategories into broader categories based on thematic similarities. Finally, we extracted key categories and significant phrases from the transcripts, presenting our final analysis in narrative form.

Data collection

Data collection was performed by a research assistant who remained blinded to group assignments throughout the study. Following written informed consent, patients received explanations regarding the study's objectives and questionnaire completion requirements. On the day of discharge (T0), patients were instructed to complete paper-based quality of life and self-management efficacy questionnaires. At 2 weeks post-discharge (T1), data from the control group were gathered via telephone interviews, while the experimental group completed system-distributed questionnaires. To ensure questionnaire quality, data at 4 weeks (T3) and 12 weeks (T4) post-discharge were collected through paper-based questionnaires during outpatient visits. For patients missing appointments, telephone interviews were conducted by the research assistant to assess self-efficacy and quality of life. Patients were reminded of upcoming follow-ups after each session. Ideally, patients completed questionnaires independently; during telephone interviews, questions were read aloud and answers objectively recorded. Any missing, incomplete, or erroneous data were promptly addressed and corrected by the research assistant following questionnaire completion.

statistical methods

Continuous variables following a normal distribution were analyzed using the t-test. Demographic and clinical characteristics between the two groups were compared using the Chi-square test or Fisher's exact test for categorical variables, and the Mann-Whitney U test for ordinal data. Generalized Estimating Equations (GEE) were employed to assess group, time, and interaction effects on quality of life and self-efficacy. A linearized approach with an unstructured correlation matrix was utilized in the GEE analysis, and post hoc tests were conducted using the least significant difference method. Statistical analyses were conducted using SPSS 26.0 software, with significance set at P <.05 (two-tailed).

Results

Paticipants flow and recruitment

A total of 266 participants were screened initially, from which 240 met the study criteria and voluntarily enrolled. They were randomly assigned to either the experimental group (n = 120) or the control group (n = 120). Of these, 213 participants (88.75%) completed the three-month follow-up: 105 in the experimental group and 108 in the control group. Reasons for withdrawal from the study included severe postoperative complications (3), loss of contact (18), refusal to follow-up (5), and contamination (1) (Figure 1).

Among the 213 subjects, the average age was 57.71 years, with 54.0% aged 60 years or older. The majority were female (59.6%) and had attained a high school education or higher (76.1%). Most were married (90.6%), employed (67.1%), and resided in urban areas (60.6%). A small proportion (2.3%) had a monthly household income per capita of less than 2000 yuan. Medically, the cohort predominantly had adenocarcinoma (96.2%), lacked chronic diseases (66.7%), were diagnosed with early-stage lung cancer (stage 0-I, 77.0%), and underwent minimally invasive thoracoscopic surgery (94.4%). Approximately 28.2% received postoperative radiotherapy or chemotherapy. During hospitalization, the average duration of chest tube placement was 64.84 hours, with an average postoperative hospital stay of 3.31 days and a total hospital stay averaging 6.19 days. Baseline characteristics were comparable between the experimental and control groups (Table 1).

Effects on quality of life

The GEE results indicated significant inter-group differences in quality of life between the two groups (Wald χ^2=5.204, P =.023). Specifically, at T2, the quality of life in the experimental group was significantly higher than that in the control group (t=2.515, P=.013), while no statistically significant differences were observed at T0, T1, and T3. Both groups exhibited improvements in quality of life across all time points (Wald χ^2=574.167, P <.001), with no significant interaction between group and time differences (Wald χ^2=2.354, P =.308). Figure 2 depicts the average quality of life scores over time for both groups, showing a more rapid improvement in the experimental group compared to the control group.

Effects on self-management

Regarding self-management efficacy, the GEE results revealed significant differences between the two groups (Wald χ^2=6.573, P=.010). Specifically, at T2 and T3, self-management efficacy in the experimental group was significantly higher than in the control group (t=3.024, P=.003; t=2.214, P =.028), while no significant differences were observed at T0 and T1. Both groups showed improvements in self-management efficacy across all time points (Wald χ^2= 301.390, P<0.001), with no significant interaction between group and time (Wald χ^2=3.971, P=.137). Figure 3 depicts the average self-management efficacy scores over time for both groups, illustrating a faster improvement in the experimental group compared to the control group from T0 to T3. Additionally, both groups experienced more rapid growth in self-management efficacy from T1 to T3 compared to T0 to T1.

Figure 1. CONSORT flow diagram.

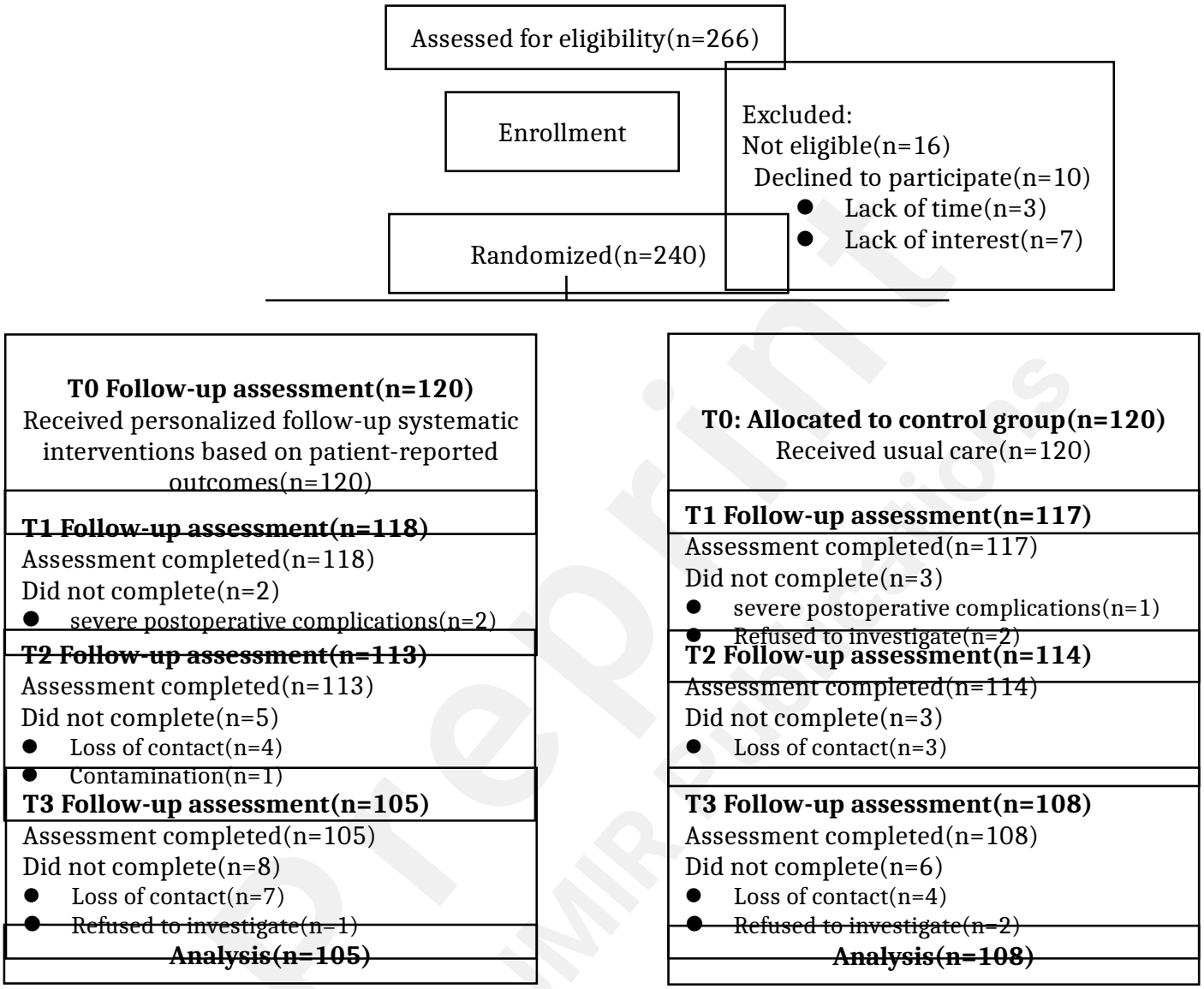

Table 1. Demographic and clinical characteristic and outcome variables.

Variable	$\bar{x}$±s or No.(%)		$t/x^2/z$	P
	Intervention group（n=105）	Control group（n=108）		
Age(years)	57.55±13.18	57.87±11.29	-0.189	.850[a]
Sex				
Male	42(40.0)	44(40.7)	0.012	.912[b]
Female	63(60.0)	64(59.3)		
Body mass index	23.69±3.61	23.58±2.65	0.242	.809[a]
Education level				
Junior high school and below	25(23.8)	26(24.1)	-0.071	.944[c]
High school or technical secondary school	12(11.4)	8(7.4)		
junior college or undergraduate degree	59(56.2)	68(63.0)		
Master degree and above	9(8.6)	6(5.6)		
Marital status				
Unmarried	5(4.8)	2(1.9)	—	.477[d]
Married	93(88.6)	100(92.6)		
Widowed or divorced	7(6.7)	6(5.6)		
Work status				
On job	72(68.6)	71(65.7)	1.456	.483[b]
Retired	24(22.9)	31(28.7)		
Unemployed	9(8.6)	6(5.6)		
Residence				
Town	63(60.0)	66(61.1)	1.816	.178[b]
Countryside	42(40.0)	42(38.9)		
Monthly income per person(yuan)				
≤2000	2(1.9)	3(2.8)	-0.933	.351[c]
2001—4000	40(38.1)	42(38.9)		
4001—6000	28(26.7)	37(34.3)		
＞6000	35(33.3)	26(24.1)		
Postoperative radiotherapy or chemotherapy				
Yes	77(73.3)	76(70.4)	0.231	.631[b]
No	28(36.7)	32(29.6)		
Tumor Type				
Adenocarcinoma	100(95.2)	105(97.2)	—	.494[d]
Others	5(4.8)	3(2.8)		
Surgery type				

Table 1 (continued)

minimally invasive thoracoscopy	100(95.2)	101(93.5)	0.296	.586[b]
open surgery	5(4.8)	7(6.5)		
Surgical methods				
wedge resection	33(31.4)	31(28.7)	2.984	.394[b]
segmentectomy	30(28.6)	40(37.0)		
lobectomy	32(30.5)	24(22.2)		
others	10(9.5)	13(12.0)		
TNM stage				
0	12(11.4)	18(16.7)	—	.541[d]
Ⅰ	68(64.8)	66(61.1)		
Ⅱ	22(21.0)	23(21.3)		
Ⅲ	3(2.9)	1(0.9)		
Comorbid chronic diseases				
Yes	33(31.4)	38(35.2)	0.338	.561[b]
No	72(68.6)	70(64.8)		
Preoperative lung function				
FVC	2.94±0.68	3.34±2.93	-1.391	.171[a]
FEV1/FVC	80.66±6.91	82.25±6.25	-1.766	.079[a]
Chest drainage tube indwelling time(hours)	60.69±36.92	68.88±42.82	-1.494	.136[a]
Postoperative hospital stay(days)	3.12±1.80	3.49±1.94	-1.429	.154[a]
Total length of stay(days)	6.02±2.40	6.36±2.73	-0.971	.333[a]

[a]Independent samples *t*-test

[b]chi–square tests

[c]Mann-Whitney *U* test

[d]Fisher exact test

Table 2. Comparison of outcome variables of participants between intervention and control groups at different time points.

Variable	Group	On the day of discharge (mean ± SD)	2 weeks after discharge (mean ± SD)	1 month after discharge (mean ± SD)	3 months after discharge (mean ± SD)	Group Wald X^2 (P)	Time WaldX^2 (P)	Group*Time WaldX^2 (P)
Quality of Life	Intervention	85.38±12.46	100.43±14.82	113.46±11.05	119.29±8.67	5.204 (.023)	574.167 (<.001)	2.354 (.308)
	Control	85.94±10.42	98.14±10.31	109.97±10.25	116.82±9.75			
	t	-0.353	1.306	2.515	1.945			
	P	0.725	0.193	0.013*	0.053			
self-management efficacy	Intervention	90.27±11.48	92.84±13.14	99.67±12.48	104.09±11.92	6.573 (.010)	301.390 (<.001)	3.971 (.137)
	Control	89.14±12.12	89.48±12.99	94.56±12.15	100.41±12.31			
	t	0.697	1.864	3.024	2.214			
	P	0.487	0.064	0.003*	0.028*			

Figure 2. Changes in mean scores of quality of life.

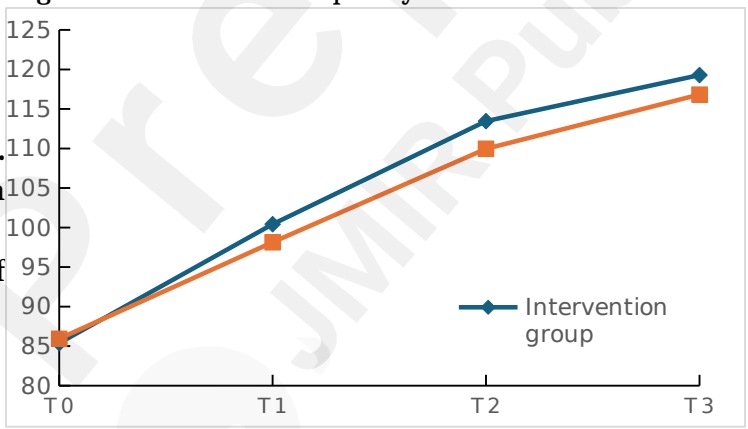

Figure 3. Changes in mean scores of self-management efficacy.

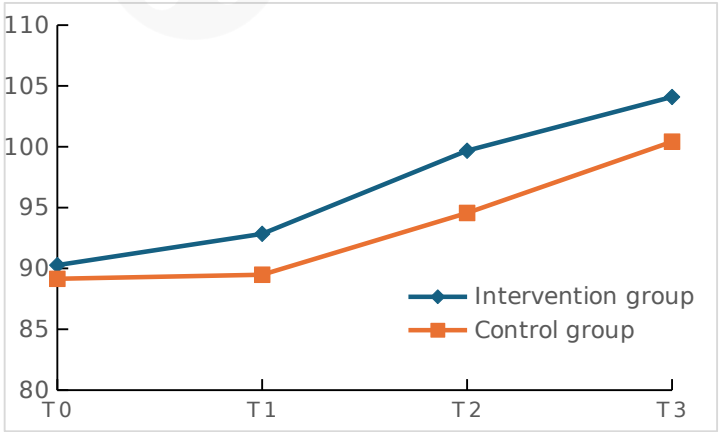

Table 3. Comparison of Quality of life and Self-management efficacy and their various dimensions after group intervention.

Variable	Group	On the day of discharge		2 weeks after discharge		1 month after discharge		3 months after discharge	
		mean ± SD	*t, P*	mean ± SD	*t, P*	mean ± SD	*t, P*	mean ± SD	*t, P*
Quality of life	Intervention	85.38±12.46	-0.353, .725	100.43±14.82	1.306, .193	113.46±11.05	2.515, .013[a]	119.29±8.67	1.945, .053
	Control	85.94±10.42		98.14±10.31		109.97±10.25		116.82±9.75	
physiological	Intervention	18.84±4.85	0.250, .803	20.48±4.81	0.232, .817	23.84±3.16	1.636, .103	24.74±2.90	1.840, .067
	Control	18.69±4.03		20.34±3.48		23.18±2.73		24.00±2.99	
society	Intervention	18.66±3.38	-0.561, .575	20.42±5.20	-1.328, .186	22.53±3.61	-0.109, .914	24.75±2.99	-1.346, .180
	Control	18.94±3.83		21.41±5.65		22.58±3.10		25.29±2.81	
emotion	Intervention	16.18±3.86	0.804, .422	17.55±3.32	2.493, .013[a]	18.67±3.02	2.687, .008[a]	19.30±2.93	1.572, .117
	Control	15.72±4.45		16.48±2.93		17.63±2.59		18.63±3.33	
Function	Intervention	10.19±3.33	-0.411, .681	15.43±3.52	2.044, .042[a]	20.19±3.76	1.719, .087	21.37±3.28	2.301, .022[a]
	Control	10.39±3.70		14.56±2.56		19.41±2.81		20.41±2.81	
Additional attention	Intervention	21.51±4.73	-1.178, .240	26.55±4.43	2.221, .027[a]	28.23±3.37	2.537, .012[a]	29.11±3.64	1.213, .226
	Control	20.20±3.75		25.34±3.44		26.99±3.74		28.50±3.75	
Self-management efficacy	Intervention	90.27±11.48	0.697, .487	92.84±13.14	1.864, .064	99.67±12.48	3.024, .003[a]	104.09±11.92	2.214, .028[a]
	Control	89.14±12.12		89.48±12.99		94.56±12.15		100.41±12.31	
Self-decompression	Intervention	29.89±4.59	0.481, .631	29.95±5.68	0.569, .570	34.99±5.93	2.103, .037[a]	36.66±7.20	0.703, .483
	Control	29.58±4.59		29.50±5.92		33.26±6.08		35.97±7.01	
self-decision	Intervention	9.46±2.08	0.434, .665	11.56±1.79	1.744, .083	12.44±1.94	2.600, .010[a]	12.67±2.13	-0.797, .427
	Control	9.32±2.39		11.06±2.32		11.70±2.17		12.89±1.94	
positive attitude	Intervention	50.92±6.72	0.754, .452	51.30±7.27	2.366, .019[a]	52.24±7.45	2.519, .013[a]	54.76±7.42	3.114, .002[a]
	Control	50.23±6.69		48.92±7.46		49.60±7.81		51.55±7.65	

[a]p□.05

Table 4. Paired comparison of estimated marginal means of quality of life and Self-management Efficacy.

Variable	Group	Mean Difference	Standard Error	*t*	*P* value	95% CI lower limit	95% CI upper limit
	Control						
	T0-T1	-12.204	12.826	-9.988	<.001	-14.650	-9.757
	T0-T2	-23.852	12.178	-20.355	<.001	-26.175	-21.529
	T0-T3	-30.889	11.630	-27.601	<.001	-33.107	-28.670
	T1-T2	-11.648	6.527	-18.546	<.001	-12.893	-10.403
	T1-T3	-18.685	6.800	-28.557	<.001	-19.982	-17.388
quality of	T2-T3	-7.037	4.478	-16.330	<.001	-7.891	-6.183
life	**Intervention**						
	T0-T1	-15.048	15.198	-10.146	<.001	-17.989	-12.106
	T0-T2	-28.076	15.064	-19.098	<.001	-30.991	-25.161
	T0-T3	-33.905	14.174	-24.512	<.001	-36.648	-31.162
	T1-T2	-13.029	16.375	-8.153	<.001	-16.198	-9.860
	T1-T3	-18.857	16.471	-11.731	<.001	-22.045	-15.670
	T2-T3	-5.829	7.350	-8.125	<.001	-7.251	-4.406
	Control						
	T0-T1	-0.343	6.590	-0.540	0.590	-1.600	0.914
	T0-T2	-5.426	7.053	-7.995	<.001	-6.771	-4.081
	T0-T3	-11.269	7.730	-15.150	<.001	-12.743	-9.794
	T1-T2	-5.083	7.724	-6.836	<.001	-6.557	-3.610
Self-	T1-T3	-10.926	9.081	-12.504	<.001	-12.685	-9.194
management	T2-T3	-5.843	6.716	-9.041	<.001	-7.124	-4.561
efficacy	**Intervention**						
	T0-T1	-2.552	6.265	-4.175	<.001	-3.765	-1.340
	T0-T2	-9.400	6.728	-14.317	<.001	-10.072	-8.089
	T0-T3	-13.819	8.224	-17.219	<.001	-15.411	-12.228
	T1-T2	-6.848	6.899	-10.171	<.001	-8.183	-5.513
	T1-T3	-11.267	9.840	-11.723	<.001	-13.171	-9.362
	T2-T3	-4.419	9.030	-5.015	<.001	-6.167	-2.672

Table 5. Content analysis of attitudes towards device usage from patients.

Categories	Patients' quotations
Convenience, Speed, and Dynamic Assessment	**Code 25**: I often feel tightness in my chest, which becomes noticeable with slight activity. This feeling makes me anxious, but I quickly fill out the form and can provide timely feedback to you.
	Code 14: The pathology report results haven't come out yet, and I'm still worried. There's a yellow discharge from the wound, which I know isn't beneficial for recovery.
	Code 22: It's convenient. I don't have to wait until the next check-up to inform you about my condition. This way, I can reflect on the dynamic process of my symptoms.
Enhancing Self-management Awareness and Skills	**Code 11:** I've started paying attention to things I didn't notice before. It has made me more aware of my symptoms in certain aspects.
	Code 44: During a gout attack, I can't move much. I receive physical function training methods from you, which I find very helpful.
	Code 8: I know what I should do. Recovery after discharge is also part of my treatment that I am taking seriously.
Feeling Supported and Confident	**Code 102:** I feel cared for and valued with reminders at each stage.
	Code 5: I feel much better after completing the reminders. I think it's not just psychological; feeling cared for and supported by healthcare staff matters.
Perceived Reporting Pressure	**Code 12:** Reading and selecting answers one by one can be tiresome over time.
	Code 36: I feel I'm recovering quite well, so sometimes filling it out feels burdensome.
Limited Technological Acceptance	**Code 56:** My son occasionally helps me with operating it. I think many elderly find it troublesome to use.
Concerns about Reliability	**Code 21:** When doctors or nurses directly ask about my symptoms, they seem more reliable. I feel safer when conveying my concerns to doctors, as talking to someone seems more reliable.

Adherence to the study intervention

The mean (standard deviation) number of reports from patients in the experimental group was 14.46 (3.048). Among these patients, 72.4% completed all 16 reports, while 15.2% completed 10 or fewer reports. Additionally, we received a total of 46 reports from 32 patients when they perceived a need to report.

We collected 108 reasons for non-compliance, which were categorized as follows: pressure from multiple entries (38.9%), low willingness due to physiological and psychological factors (30.6%), forgetfulness (25%), operational issues (2.7%), device-related issues (1.9%), and rehospitalization (0.9%). Table 5 presents a content analysis of attitudes towards device usage from 105 patients, identifying six main categories: "convenience, rapid and dynamic assessment," "enhanced self-management awareness and skills," "feeling supported and confident," "perceived reporting pressure," "limited technological acceptance," and "concerns about reliability."

Discussion

Principal Results

To our knowledge, this study provides compelling evidence in China of a personalized follow-up program for postoperative lung cancer patients based on patient-reported outcomes. This program, utilizing a WeChat mini-program embedded with the MD Anderson Symptom Inventory and alarm thresholds, was led by nurses with multidisciplinary team support. It focuses on precise assessment and identification of personalized needs to deliver intelligent and accurate solutions.

Over time, the two groups exhibited significant differences in quality of life and self-management efficacy. Notably, despite a small number of participants dropping out early in the study, all members of the intervention group actively engaged in the three follow-up assessments. Although their reporting frequency did not strictly adhere to all preset requirements, their sustained participation demonstrated high enthusiasm and compliance, thereby enhancing the study's reliability. Additionally, we conducted a preliminary content analysis of patients' reported opinions on device use in the trial group, identifying six categories that reflect the opportunities and challenges presented by personalized follow-up plans for patient-reported outcomes in lung cancer care. These findings highlight directions for improving the quality of continuing care and provide valuable insights for developing and implementing more targeted interventions.

Comparison with Prior Work

In contrast to previous studies on integrating patient-reported outcomes into the ongoing care of postoperative lung cancer patients, our study focused on the process of program construction. Given the complexity of implementing mobile device-based interventions, we identified four key aspects of implementation: evidence translation, staff training, patient-reported outcome tool setup, and multidisciplinary collaboration. These strategies effectively ensure the implementation of personalized follow-up programs based on patient-reported outcomes (see Multimedia Supplementary Material 2). Additionally, the patient reporting tool we employed is designed to minimize reporting burden while ensuring completeness, and to enhance patients' attention and compliance through three reinforced reminders for each report.

The assessment of quality of life comprehensively captures the multidimensional aspects of patients' postoperative recovery, including functional restoration, subjective feelings, psychological status, and social activities, providing a detailed overview of postoperative rehabilitation[5]. Denis et al. [21]highlighted the potential of patient-reported data in predicting cancer recurrence and promoting early treatment. They also pioneered the idea that supportive care based on patient-reported data could effectively improve patients' quality of life. Although this benefit has not yet been directly demonstrated in their research, it opens new directions for future medical practices and care models. Our study aims to explore this hypothesis in depth. In our study, quality of life, as a main outcome measure, showed significant differences between the experimental and control groups in emotional and functional dimensions, as well as in additional patient attention. Regular symptom reporting through patient-reported tools allows healthcare teams to timely access this information[34], recommend specific diet, exercise, or psychological support programs, and provide early intervention for severe symptoms, thereby improving postoperative rehabilitation and quality of life[35, 36]. A recent systematic literature review[24] emphasized that systematic evaluation of patient-reported data helps identify social and psychological issues, increasing the frequency of discussions on emotional function and the use of supportive therapeutic measures. However, our comparison of intergroup differences showed statistically significant differences in quality of life only at one month postoperatively. Prasongsook et al.[25] also confirmed better trends in scores of living quality for patients using a lung cancer care application compared to routine care monitoring, but this was observed only in a small group of advanced lung cancer patients during the COVID-19 pandemic. Conversely, Kuo et al. [37] found no significant improvement in patients' quality of life over a broader time frame. Although both studies were conducted in advanced lung cancer patients, their limited relevance to our results suggests that continuously improving patient quality of life is a complex, long-term process[21] that future studies require consideration of various factors, including advances in medical technology, optimization of nursing services, and individual

patient circumstances.

Self-efficacy is defined as an individual's firm belief in their capability to execute specific actions. It has long been regarded as a core element influencing patients' ability to self-manage their symptoms[38]. Its importance lies profoundly in self-efficacy shapes one's thought patterns, emotional experiences, levels of self-motivation, and actual performance[39]. Enhancing a patient's self-efficacy is not only effective in improving emotional states in the short term but is also crucial for promoting long-term psychological adaptation and health adjustments. A systematic review by Warrington [40] revealed that less than half of existing electronic symptom reporting systems for cancer patients during treatment integrated functionalities for providing symptom self-management guidance. Even fewer systems, less than one-third, allowed patients to access general educational information. In this study, patients in the experimental group used the follow-up system to better understand their health status and enhance their self-management capabilities. This program provided health education and rehabilitation guidance, helping patients cope with the challenges of their illness. Continuous monitoring and feedback enabled patients to understand changes in their condition, thereby boosting their confidence in managing their health[41]. Personalized guidance enabled patients to manage their health more effectively, increasing their initiative and confidence during rehabilitation. Timely feedback reassured patients that their health issues were being taken seriously and addressed. Providing comprehensive health education resources helped patients better understand their disease, treatment plans, and rehabilitation measures. By increasing their knowledge and skills, patients were better equipped to face health challenges and enhance their self-management abilities[42, 43].

In this study, the electronic assessment significantly streamlined data processing, enabling real-time assessment and dynamic monitoring. The system automatically flagged and highlighted critical values, assisting the medical team in promptly identifying and responding to urgent symptoms. The study found that patient compliance in the experimental group was higher than in similar domestic studies[44], indicating patients' acceptance and willingness to use the follow-up program. In addition, the most common reasons for non-compliance are "pressure to fill in multiple times" (38.9%) and "low willingness to fill in due to physiological and psychological factors" (30.6), leading to a decrease in compliance. This suggests that the design of the follow-up program should balance the frequency of reporting with patients' capacity for acceptance[45, 46]. Future research could consider the potential flexibility of patient-reported instruments to adapt to different filling levels among idiosyncratic patients. Similarly, a long-term tracking study involving 826 patients[22] demonstrated that using a smartphone application to aggregate patient self-reported symptoms was highly feasible and efficient for continuous monitoring of postoperative recovery in lung surgery patients. This solution not only avoided adding additional

workload to medical staff but also efficiently collected valuable data from a large number of patients within just eight months. It accurately identified key factors affecting different recovery paths after lung surgery. This indicates the potential for integrating smartphone-based communication applications into standard postoperative follow-up procedures[47], enhancing the convenience of medical services and supporting the development of more personalized and comprehensive patient-centered surgical outcome evaluations.

The high participation and compliance rates, along with the positive qualitative feedback received, underscore the successful engagement of participants and offer valuable insights into the design and implementation of continuity-of-care programs for lung cancer patients based on patient-reported outcomes. This study lays an important foundation for optimizing future programs and research designs, particularly in ensuring device suitability for the lung cancer population. However, it is worth noting that this study limited the use of smart devices when patients were initially recruited. Additionally, we found that the age and education level of the patients in this study were higher than those in previous studies, which may have contributed to the good compliance observed. Future research should consider these factors to further improve program design and generalizability.

Limitations

This study has several limitations. First, participants were recruited from a tertiary hospital in Shanghai, and those willing to join may have had higher social participation. Future studies should include participants from a broader geographical range and diverse backgrounds to improve the generalizability of findings and provide a higher level of evidence. Additionally, our outcome measures were self-assessed, which may introduce subject bias. Furthermore, due to limited clinical resources, the same group of nurses provided both the experimental and control interventions, potentially leading to contamination between the groups. Lastly, patients reported multiple times, which may have affected our sensitivity in documenting changes in patient-reported outcomes over time. Adding intermediate measurements could allow for a more detailed investigation of changes and reveal significant intervention effects during the postoperative course of lung cancer.

Conclusions

This study demonstrates that a three-month follow-up program based on patient-reported outcomes significantly improves the postoperative quality of life and self-management levels of lung cancer patients, confirming the short-term intervention effects. However, a longer intervention period and continuous follow-up support may be needed to sustain these improvements in patient adherence and health outcomes. The satisfactory patient adherence observed in this study indicates the feasibility of integrating patient-reported outcomes into the continuity of care for postoperative lung cancer patients.

Data Availability

The data sets generated and analyzed during this study are available from the corresponding author on reasonable request.

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Authors' Contributions

Luo Yiqing: Writing – original draft, Validation, Methodology, Investigation, Formal analysis.
Cheng Yuna: Validation, Resources, Methodology, Investigation, Formal analysis.
Song Zuodong: Writing – review & editing, Software.
Chen Hui: Writing – review & editing, Visualization, Validation, Supervision, Resources, Methodology, Conceptualization.
Bo Yinping: Supervision, Resources, Project administration.
ShiXing Haobo: Data curation, Software.

Conflicts of Interest

none declared.

Abbreviations

ERAS: Enhanced Recovery After Surgery
PROs: Patient-Reported Outcomes
GEE: Generalized Estimating Equations
RCT: randomized controlled trial

Multimedia Appendix 1

CONSORT checklist.

Multimedia Appendix 2

Implementation strategies and specific contents of personalized follow-up program for lung cancer patients based on patient-reported outcomes.

Multimedia Appendix 3

Functional display of WeChat applet for personalized follow-up of lung cancer patients based on patient-reported outcomes.

Multimedia Appendix 4

Two scales and scores of each dimension at four time points.

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Supplementary Files

Multimedia Appendixes

CONSORT checklist.
URL: http://asset.jmir.pub/assets/8f2c0fcac20e711926cdf22ce7672ca0.doc

Implementation strategies and specific contents of personalized follow-up program for lung cancer patients based on patient-reported outcomes.
URL: http://asset.jmir.pub/assets/b0b77cf94250c9f34053dea4de1f6363.doc

Functional display of WeChat applet for personalized follow-up of lung cancer patients based on patient-reported outcomes.
URL: http://asset.jmir.pub/assets/9e29f43057a30a65b38d926049ff330c.doc

Two scales and scores of each dimension at four time points.
URL: http://asset.jmir.pub/assets/099eac5676b44a1b305e8c438b53d62b.zip