Alqalam Journal of Medical and Applied Sciences. 2026;9(4):824-832
https://doi.org/10.54361/ajmas.269406

Original article

The Effectiveness of ICOUGH Care Program on Dyspnea, Respiratory Parameters, Mobility, and Pain After Major Abdominal Surgery: Randomized Controlled Study

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Abstract
This study evaluated the effectiveness of the ICOUGH care program in improving pulmonary function, mobility, dyspnea, and pain after major abdominal surgery. A randomized clinical trial was conducted in tertiary hospitals in Tripoli, Libya, including 60 patients assigned to an experimental group (n = 30) and a control group (n = 30). The experimental group received the ICOUGH program, which included incentive spirometry, oral care, coughing and breathing exercises, patient and family education, early mobilization, and head-of-bed elevation, while the control group received routine care. Outcomes included vital signs, pulmonary function (FEV1, FVC, FEV1/FVC, PEF), dyspnea (Modified Borg Dyspnea Scale), mobility (AMP tool), and pain (VAS). The experimental group demonstrated significant improvements in dyspnea ($p = 0.002$), FEV1 ($p = 0.026$), FEV1/FVC ($p = 0.010$), PEF ($p < 0.001$), and pain ($p = 0.002$) compared to the control group. No significant differences were observed in FVC ($p = 0.159$) or mobility ($p = 0.874$). The ICOUGH program significantly improved respiratory outcomes and reduced postoperative symptoms, supporting its integration into routine postoperative care to enhance recovery and reduce complications.
Keywords. ICOUGH, Dyspnea, Respiratory Function, Pain, Abdominal Surgery.

Introduction

Postoperative pulmonary complications (PPCs) are a leading cause of morbidity, mortality, and prolonged hospitalization following surgery and general anesthesia [1–3]. These complications arise from impaired respiratory mechanics—including reduced respiratory drive, weakened respiratory muscles, and diminished lung volumes, particularly functional residual capacity (FRC)—as well as atelectasis [1]. Common PPCs include pneumonia, respiratory failure, bronchospasm, and prolonged mechanical ventilation [4,5]. Globally, more than 230 million major surgeries are performed each year [6,7].
Major abdominal surgery (MAS) frequently leads to PPCs due to impaired breathing and decreased oxygenation [8,9]. These risks are aggravated by anesthesia, pain, and immobility [10,13]. Postoperative hypoxemia is driven by atelectasis and ventilation-perfusion mismatch [13]. Immobility contributes to poor outcomes, whereas early mobilization improves prognosis [14]. Pain reduces lung volumes and compliance with physiotherapy [4,15,16]. Preventive strategies such as breathing exercises and physiotherapy reduce PPCs [16,19]. However, they are often applied inconsistently [20]. The ICOUGH care program integrates multiple interventions, including incentive spirometry, oral care, breathing exercises, education, mobilization, and positioning [21]. This study evaluated the effectiveness of the ICOUGH care program in improving pulmonary function, mobility, dyspnea, and pain after major abdominal surgery.

Methods

Study Design and Participants

This prospective, parallel-group randomised clinical trial was conducted across three tertiary hospitals in Tripoli, Libya: Royal Hospital, Al-Khalil Hospital, and Al-Assema Hospital. A total of 60 patients scheduled for MAS were recruited. All participants provided written informed consent after receiving both verbal and brochure-based explanations of study procedures. Ethical approval was obtained from the Yeditepe University Non-Interventional Clinical Research Ethics Committee (Approval No: 202204Y0239). The study was also registered on ClinicalTrials.gov with the ID number of NCT06255327.
Inclusion criteria were: adults aged 30–60 years undergoing elective abdominal surgery under general anesthesia, with incisions ≤5 cm above or below the umbilicus, and no expected intensive care unit stay. Exclusion criteria included: unstable cardiac conditions, pulmonary hypertension, unstable blood pressure, active malignancy, cerebrovascular disease, severe systemic illnesses, balance or vestibular disorder, or admission to the intensive care unit postoperatively.
Sample size was calculated using G*Power software based on a medium effect size for changes in respiratory rate, with a power of 0.80 and alpha set at 0.05. Power analysis indicated that a minimum of 27 participants per group was required to achieve 80% power at a 5% significance level. A total of 62 participants were initially assessed for eligibility. Two participants were excluded prior to randomization as they did not meet the inclusion criteria. Finally, 60 participants were randomized equally into the experimental group (n = 30)

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Received*: 02-02-2026 -* ***Accepted****: 01-04-2026 -* ***Published****: 07-04-2026*

https://doi.org/10.54361/ajmas.269406

and the control group (n = 30), and all were included in the final analysis. All participants were referred by consultant general or bariatric surgeons and voluntarily agreed to participate in the study.

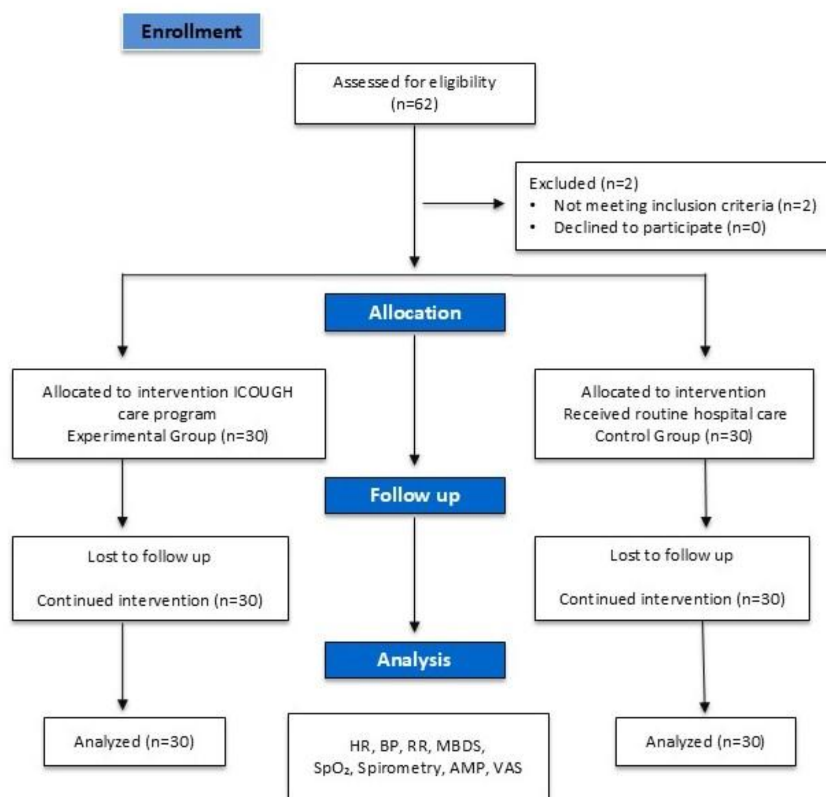

Figure 1. CONSORT flow diagram of participant recruitment, allocation, and analysis.

Intervention

Participants in the control group were assessed on the first postoperative day (10 hours after surgery) and again on the day of hospital discharge. No specific education or training was provided to the control group before or after surgery, and participants received routine hospital care only, which included standard pain management with intravenous analgesics, regular wound care, and encouragement of early mobilization (limited to walking). Pulmonary rehabilitation was provided using a traditional method, consisting of a 10-cc syringe with a rubber glove attached, in which patients were instructed to blow into the device. This method was administered without structured instructions or standardized supervision.

Participants in the experimental group received the ICOUGH care program, which comprises incentive spirometry, coughing and deep breathing exercise, oral care, understanding (patient and family education), getting out of bed, and head-of-bed elevation. The program was initiated 10 hours after surgery, once patients were able to participate.

The ICOUGH program was delivered by a specialized respiratory physiotherapist according to standardized guidelines: Education: Patients and their relatives received structured instruction on the ICOUGH program using a brochure. Incentive spirometry: Patients were instructed to perform 10 inhalations every two hours for three days postoperatively, holding each breath for 3–5 seconds before exhalation. The flow-oriented device provided visual feedback, and family members were encouraged to assist adherence. Coughing and deep breathing exercise (CDB): Patients performed 3–5 repetitions every two hours, bracing the surgical incision during coughing to reduce discomfort. Each session was repeated two to three times. Pain during CDB was monitored and recorded. Oral care: Oral hygiene was performed twice daily (8:00 a.m. and 8:00 p.m.) using sterile toothbrushes, fluoride toothpaste, and non-alcoholic mouthwash to reduce bacterial colonization and aspiration risk. Early mobilization: On the day of surgery, patients were assisted to sit in a chair at least once and to ambulate three times daily in the room or corridor, with progression as tolerated. Head-of-bed elevation: Patients were positioned with the head of the bed elevated ≥30° throughout their hospital stay to promote lung expansion, optimise diaphragm excursion, and reduce aspiration risk.

Outcome Measurements

All participants were evaluated on the first postoperative day (10 hours after surgery) and again on the day of hospital discharge. Assessments included heart rate (HR), blood pressure (systolic and diastolic; SBP/DBP), respiratory rate (RR), oxygen saturation (SpO_2), the Modified Borg Dyspnea Scale (MBDS), pulmonary function tests included forced expiratory volume in 1 second (FEV_1), forced vital capacity FVC,

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

https://doi.org/10.54361/ajmas.269406

forced expiratory volume in one second to forced vital capacity (FEV_1/FVC), and peak expiratory flow (PEF), the Activity and Mobility Promotion (AMP) tool, and the Visual Analog Scale (VAS). All measurements were conducted by a respiratory physiotherapist using standardized procedures. Baseline demographic data, medical history, comorbidities, and previous surgical procedures were recorded using a structured face-to-face questionnaire designed by the researcher. Patients also received verbal information and an illustrated brochure to ensure understanding of the procedures. Heart rate and systolic and diastolic blood pressure were measured using the Bionet BM3 Multi-Parameter Patient Monitor (Bionet America, Inc., Tustin, CA, USA). Measurements were performed with the patient seated on the bed, back supported, legs extended, and the arm positioned at heart level and free of clothing. A properly sized cuff was applied snugly around the upper arm, with the lower edge positioned approximately 2–3 cm above the antecubital fossa. For heart rate monitoring, three ECG electrodes were attached to clean, dry skin in the standard lead II configuration. Blood pressure was measured by selecting the non-invasive blood pressure function, after which the device automatically inflated the cuff, detected oscillometric signals, and displayed the systolic and diastolic readings. Heart rate values were recorded from the ECG trace shown on the monitor [22].

Respiratory rate was measured with the patient at rest in a comfortable seated or supine position. To minimize bias, the procedure was performed discreetly without drawing attention to the act of breathing. Chest or abdominal movements were observed, and the number of complete respiratory cycles (one inspiration and one expiration) was counted for 30 seconds and multiplied by two; if the breathing pattern was irregular, measurements were extended to a full 60 seconds. Results were recorded in breaths per minute [23].

Peripheral oxygen saturation (SpO_2) was measured using a pulse oximeter with the patient at rest in a seated or supine position. The probe was applied to the fingertip. Readings were taken once a stable signal and plethysmographic waveform were obtained. SpO_2 was recorded as a percentage [24].

Dyspnea severity was assessed using the Modified Borg Dyspnea Scale (MBDS), a validated 0–10 category-ratio scale that quantifies the patient's subjective perception of breathlessness. Patients were instructed to select the number that best represented their breathing discomfort at rest or following activity, where 0 = no breathlessness and 10 = maximal breathlessness. Scores greater than 0 indicated the presence of dyspnea, with values of ≥3 ("moderate") generally considered clinically significant [25].

Pulmonary function was assessed using the CONTEC SP70B Handheld Digital Spirometer (Contec Medical Systems, China) in accordance with the American Thoracic Society and European Respiratory Society (ATS/ERS) guidelines for spirometry to ensure standardized and reproducible measurements. During testing, each participant was asked to take a deep inspiration and exhale as forcefully and rapidly as possible into the spirometer for at least six seconds to achieve maximal emptying of the lungs. The parameters recorded included FEV_1, FVC, FEV_1/FVC ratio, and PEF. Peak expiratory flow (PEF) was recorded in liters per minute (L/min). Each maneuver was repeated at least three times, and the best values were recorded for analysis [26].

Functional mobility was evaluated with the Johns Hopkins Activity and Mobility Promotion (AMP) tool, which is a standardized clinical instrument developed to assess patient mobility status and promote early mobilization in hospitalized patients. The tool includes structured questions related to the patient's ability to perform basic mobility tasks such as turning in bed, sitting, standing, transferring, and ambulating. Patient mobility is determined by directly observing performance or assessing the ability to complete these tasks safely, with or without assistance [27,28].

Pain intensity was assessed using a 10-cm Visual Analog Scale (VAS), a widely validated tool for quantifying subjective pain. Patients were specifically asked to rate their pain during coughing, as this maneuver may increase discomfort in the early postoperative period. The scale ranges from 0, indicating "no pain," to 10, representing the "worst imaginable pain." Participants were instructed to place a finger on the number that best reflected their pain intensity at the time of assessment [29].

The primary outcome was dyspnea severity measured using the Modified Borg Dyspnea Scale (MBDS). Secondary outcomes included pulmonary function parameters, oxygen saturation, mobility, and pain.

Statistical Analysis

All data were analysed using SPSS (version 23.0; IBM Corp., Armonk, NY, USA). Normality was tested using the Shapiro–Wilk test. Between-group differences were assessed with independent t-tests or Mann–Whitney U tests, depending on distribution. Within-group comparisons were made using paired t-tests or Wilcoxon signed-rank tests. Categorical variables were analysed with the Chi-square or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Results

Participants were aged between 30 and 60 years (mean 39.9 ± 8.82 years), including 47 females and 13 males. Baseline comparisons showed no statistically significant differences between the experimental group (EG) and control group (CG) across all measured variables ($p > 0.05$), confirming baseline homogeneity (Tables 1 and 2).

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

Within-group analysis for the experimental group (EG) demonstrated significant improvements from postoperative day 1 to discharge in systolic blood pressure (SBP; $p = 0.008$), respiratory rate (RR; $p < 0.001$), oxygen saturation (SpO_2; $p < 0.001$), dyspnea severity (MBDS; $p < 0.001$), forced expiratory volume in 1 second (FEV_1; $p < 0.001$), forced vital capacity (FVC; $p = 0.001$), FEV_1/FVC ratio ($p = 0.012$), peak expiratory flow (PEF; $p < 0.001$), functional mobility (AMP; $p < 0.001$), and pain intensity (VAS; $p < 0.001$). No statistically significant changes were observed in heart rate (HR; $p = 0.851$) or diastolic blood pressure (DBP; $p = 0.286$) (Table 3).

Between-group comparisons of change scores revealed that the EG demonstrated significantly greater improvements than the CG in SpO_2 ($p = 0.033$), MBDS ($p = 0.002$), FEV_1 ($p = 0.026$), FEV_1/FVC ($p = 0.010$), PEF ($p < 0.001$), and VAS ($p = 0.002$). No statistically significant differences were observed between groups for HR, SBP, DBP, RR, FVC, or AMP.

Overall, although both groups exhibited postoperative improvements, the experimental group achieved significantly greater enhancements in respiratory function, dyspnea, and pain outcomes compared with the control group.

Table 1. Comparison of Age and Gender Distribution Between Study Groups.

		EG mean (SD)	**CG mean (SD)**	***t***	***p* value**
Age (years)		40.30±8.498	39.67±8.252	- 0.276	0.784
Gender	**Male**	8 (26.7%)	5 (16.7%)	0.884	0.347
	Female	22 (73.3)	25 (83.3%)		

Table 2. Comparison of Variables Between Study Groups.

Variable	**EG mean (SD)**	**CG mean (SD)**	**t**	**p value**
HR	84.13 ± 15.542	87.47 ± 14.529	0.858	0.394
SBP	125.833 ± 11.225	122.166 ± 12.977	-1.170	0.247
DBP	73.5 ± 8.003	73.166 ± 8.952	-0.152	0.88
RR	22.63 ± 4.687	22.6 ± 3.558	-0.031	0.975
SpO_2	96.066 ± 1.659	95.833 ± 2.001	-0.492	0.625
MBDS	2.583 ± 1.898	3.067 ± 1.654	1.051	0.298
FEV_1	1.874 ± 0.604	1.712 ± 0.429	-1.194	0.237
FVC	2.458 ± 0.723	2.186 ± 0.540	-1.648	0.105
FEV_1/FVC	77.473 ± 13.345	78.933 ± 11.034	0.462	0.646
PEF	185.3 ± 100.8	173.1 ± 66.6	-0.554	0.582
AMP	3.87 ± 2.556	2.73 ± 1.911	-1.945	0.057
VAS	5.067 ± 2.148	5.483 ± 1.905	0.795	0.430

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

Alqalam Journal of Medical and Applied Sciences. 2026;9(4):824-832
https://doi.org/10.54361/ajmas.269406

Table 3. Comparisons of Variables Were Conducted Within the Control Group, Within the Experimental Group, and Between Both Groups on the First Day Post-Surgery and the Day Before Discharge.

Variables	CG				EG				Comparing Groups					
	First day post OP	Day of discharge	t	p value	First day post OP	Day of discharge	t	p value	EG	CG	t	p value	CI (95%)	
	mean (SD)	mean (SD)			mean (SD)	mean (SD)			Δ ± SD	Δ ± SD			Lower	Upper
HR	87.47±14.529	88.27 ±12.542	-0.623	0.538	84.13 ± 15.542	83.83 ±12.51	0.189	0.851	0.3000 ± 8.682	0.8 ± 7.038	0.539	0.592	2.984	5.184
SBP	122.166 ± 12.977	120 ± 13.130	1.295	0.205	125.833 ± 11.225	121.5 ± 9.66	2.868	0.008	4.3333 ± 8.276	2.1667 ± 9.161	0.961	0.340	2.345	6.678
DBP	73.166 ± 8.952	72.8333 ± 9.255	0.311	0.758	73.5 ± 8.003	75.33 ± 6.00	-1.087	0.286	1.8333 ± 9.236	0.3333 ± 5.862	-1.085	0.283	6.164	1.831
RR	22.6 ± 3.558	22.1 ± 2.631	1.101	0.28	22.63 ± 4.687	18.3 ± 2.68	5.758	0.001	4.333 ± 4.121	0.5000 ± 2.487	0.119	0.906	7.410	8.343
SpO_2	95.833 ± 2.001	96.30 ± 1.643	-2.041	0.050	96.066 ± 1.659	97.27 ± 1.337	-4.871	0.001	1.200± 1.349	0.466 ± 1.252	-2.182	0.033	1.406	0.060
MBDS	3.067 ± 1.654	2.4 ± 1.561	2.347	0.026	2.583 ± 1.898	0.517 ± 1.482	6.43	0.001	2.0667 ± 1.760	0.756 ± 1.555	3.264	0.002	0.541	2.258
FEV_1	1.712 ± 0.429	1.802 ± 0.800	-0.603	0.551	1.874 ± 0.604	2.374 ± 0.630	-1.289	0.001	0.4997 ± 0.557	0.089 ± 0.811	-2.282	0.026	0.770	0.050
FVC	2.186 ± 0.540	2.3263 ± 0.855	-0.930	0.36	2.458 ± 0.723	2.862 ± 0.851	-3.745	0.001	0.4043 ± 0.591	0.14 ± 0.824	-1.427	0.159	0.635	0.106
FEV_1/FVC	78.933 ± 11.034	76.12 ± 10.480	1.122	0.271	77.473 ± 13.345	83.953 ± 6.937	-2.697	0.012	6.480 ± 13.160	2.8133 ± 13.737	-2.676	0.010	16.246	2.340
PEF	43.033 ± 17.349	42.2333 ± 16.945	0.221	0.827	45.933 ± 26.349	67.1 ± 23.439	-5.215	0.001	21.166 ± 22.230	0.8000 ± 19.834	-4.038	0.592	2.984	5.184
AMP	2.73 ± 1.911	6.67 ± 1.093	-10.260	<0.001	3.87 ± 2.556	7.7 ± 1.466	-7.690	0.001	3.833 ± 2.730	3.933 ± 2.099	0.159	0.340	2.345	6.678
VAS	5.483 ± 1.905	4.45 ± 1.662	4.545	0.001	5.067 ± 2.148	2.6 ± 1.428	6.444	0.001	2.4667± 2.096	1.0333 ± 1.245	3.220	0.283	6.164	1.831

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

Discussion

The present study demonstrated that implementation of the ICOUGH postoperative care program, which integrates a flow-incentive spirometer, structured coughing and deep breathing, scheduled oral hygiene, patient and family education, early mobilization, and semi-Fowler's positioning, can yield clinically relevant improvements in oxygen saturation, dyspnea scores, expiratory effort, and pain management after major abdominal surgery. The structured design of this multimodal approach appears to address several well-recognised contributors to postoperative pulmonary complications (PPCs), aligning with evidence from similar perioperative bundles [21,36].

From a cardiovascular perspective, there were no significant variations in diastolic blood pressure (DBP) or heart rate (HR) between the control group (CG) and experimental group (EG) on the first postoperative day or at discharge. Systolic blood pressure (SBP) remained stable in the CG, whereas the EG showed a modest postoperative change, without significant inter-group differences. Such fluctuations in blood pressure are commonly influenced by anaesthetic effects, fluid shifts, inflammation, pain, and analgesic use [30]. Our participants had no cardiovascular or pulmonary disease history, and no clinically significant haemodynamic instability or arrhythmias were observed during follow-up. These findings indicate that the ICOUGH program does not adversely affect cardiovascular stability.

Regarding respiratory parameters, both CG and EG demonstrated postoperative improvements in respiratory rate (RR), with no statistically significant differences between groups. Notably, dyspnea scores improved more in the EG, consistent with prior reports indicating that early mobilisation and respiratory retraining can reduce respiratory distress and improve breathing patterns [17,32]. Techniques such as pursed-lips breathing (PLB) and forward-leaning postures, both incorporated within the intervention, have been shown to improve diaphragmatic efficiency and reduce inspiratory muscle load, thereby alleviating dyspnea [32–35]. Additionally, maintaining head-of-bed elevation (30–45°) supports lung expansion and enhances ventilation efficiency [36,37].

Oxygen saturation (SpO_2) increased in both groups, with the EG achieving significantly greater improvements. This is consistent with findings from previous studies demonstrating that lung expansion techniques, chest physiotherapy, and positional strategies improve gas exchange and oxygenation following upper abdominal surgery [10,11,17,33,35,42,43]. These results highlight the importance of integrating structured respiratory interventions into postoperative care.

Pulmonary function test (PFT) results further supported the effectiveness of the ICOUGH program. Significant improvements in forced expiratory volume in one second (FEV_1), FEV_1/FVC ratio, and peak expiratory flow (PEF) were observed in the EG compared with the CG, indicating enhanced airway clearance and expiratory performance. These findings are consistent with previous research demonstrating that combined respiratory physiotherapy approaches are more effective than isolated techniques in improving postoperative lung function [10,44,45]. While some studies have reported limited benefits of incentive spirometry alone [15,50–53], integrating it within a comprehensive care program appears to yield greater clinical benefit [45,54,59].

Functional mobility improved in both groups over time, reflecting the role of routine postoperative care and early ambulation in recovery. However, no statistically significant difference was observed between the groups in AMP scores. This suggests that although mobility improved, the ICOUGH program did not provide additional measurable benefit beyond standard mobilization protocols in this outcome [43,45,60–63]. Studies consistently recommend early upright positioning to optimise pulmonary mechanics and enhance postoperative recovery [65–66].

Pain levels decreased in both groups, with greater reductions observed in the EG. This may be attributed to improved breathing patterns, reduced splinting behaviour, and increased patient engagement in rehabilitation. These findings are consistent with previous studies demonstrating that respiratory physiotherapy and early mobilisation can contribute to pain reduction and improved postoperative comfort [10,17,44]. Pain-related inhibition of respiratory muscle function remains an important consideration in postoperative care [9,12,55], supporting the need for integrated physiotherapy and analgesic strategies.

In conclusion, this study demonstrates that the ICOUGH program significantly improves respiratory outcomes, reduces dyspnea, and alleviates postoperative pain in patients undergoing major abdominal surgery. By integrating evidence-based physiotherapy, early mobilisation, and patient education, the ICOUGH program supports enhanced recovery and may reduce postoperative complications.

Conclusion

The ICOUGH care program improves postoperative recovery and should be integrated into standard care. Future studies with larger samples are recommended to confirm these findings.

Acknowledgments

We extend our sincere appreciation to the hospital medical directors for their cooperation and permission to conduct this study within their institutions. We are equally grateful to the general surgeons for their

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

invaluable support in facilitating participant recruitment. Our heartfelt thanks go to the surgical survivors and their families for their active engagement and commitment throughout the study. Finally, we gratefully acknowledge the generous support of Qatar Charity.

Conflicts of interest
The authors declare no conflicts of interest.

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***Received**: 02-02-2026 - **Accepted**: 01-04-2026 - **Published**: 07-04-2026*

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Received*: 02-02-2026 -* ***Accepted****: 01-04-2026 -* ***Published****: 07-04-2026*

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Received*: 02-02-2026 -* ***Accepted****: 01-04-2026 -* ***Published****: 07-04-2026*