

ESM 2. Complete Search Strategies and Search Audit Trail

Article title: Multimodal Digital Health Interventions versus Standard Perioperative Management in Lung Cancer Surgery: A Systematic Review, Meta-Analysis, and Evidence Gap Map

Journal: Supportive Care in Cancer

Authors: [replace with author names]

Corresponding author: [replace with email]

1_Search/search_strategies.md

PRISMA-S Compliant Search Strategies

Review: Multimodal Digital Health Interventions vs. Standard Perioperative Management in Lung Cancer Surgery

Date of Search: 2026-06-11

PROSPERO: CRD420261417858 (Amendment v2.0)

1. PubMed (MEDLINE)

Platform: National Library of Medicine

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

Block 1: Population - Lung Cancer + Surgery + Perioperative

```
((("Lung Neoplasms"[Mesh] OR "Carcinoma, Non-Small-Cell Lung"[Mesh] OR "Small Cell Lung Carcinoma"[Mesh]  
OR "lung cancer*" [tiab] OR "lung neoplasm*" [tiab] OR "lung carcinoma*" [tiab] OR "lung malignanc*" [tiab]  
OR "NSCLC" [tiab] OR "SCLC" [tiab] OR "pulmonary neoplasm*" [tiab] OR "pulmonary cancer*" [tiab]))
```

AND

```
("Thoracic Surgery"[Mesh] OR "Thoracic Surgical Procedures"[Mesh] OR "Pneumonectomy"[Mesh]  
OR "lung surger*" [tiab] OR "lung resection*" [tiab] OR "pulmonary resection*" [tiab] OR "thoracic surge*" [tiab]  
OR "lobectomy" [tiab] OR "pneumonectomy" [tiab] OR "segmentectomy" [tiab] OR "wedge resection" [tiab]  
OR "VATS" [tiab] OR "RATS" [tiab] OR "video-assisted" [tiab] OR "robot-assisted" [tiab] OR "thoracotom*" [tiab])
```

AND

```
("Perioperative Care"[Mesh] OR "Perioperative Period"[Mesh] OR "Preoperative Care"[Mesh]  
OR "Postoperative Care"[Mesh] OR "Enhanced Recovery After Surgery"[Mesh]  
OR "perioperat*" [tiab] OR "preoperat*" [tiab] OR "postoperat*" [tiab]  
OR "prehabilita*" [tiab] OR "rehabilita*" [tiab] OR "ERAS" [tiab] OR "enhanced recovery" [tiab]))
```

Block 2: Digital Health Intervention

```
((("Digital Health"[Mesh] OR "Telemedicine"[Mesh] OR "Mobile Applications"[Mesh]  
OR "Wearable Electronic Devices"[Mesh] OR "Artificial Intelligence"[Mesh]  
OR "Patient Reported Outcome Measures"[Mesh]  
OR "digital health*" [tiab] OR "digital therap*" [tiab] OR "digital intervention*" [tiab] OR "digital me*" [tiab]  
OR "DTx" [tiab] OR "mHealth" [tiab] OR "mobile health" [tiab] OR "eHealth" [tiab] OR "telehealth" [tiab]  
OR "telemedicine" [tiab] OR "telemonitoring" [tiab] OR "telerehabilitat*" [tiab] OR "tele-rehab*" [tiab]  
OR "wearable*" [tiab] OR "smart watch*" [tiab] OR "smartwatch*" [tiab] OR "activity track*" [tiab]  
OR "mobile app*" [tiab] OR "smartphone app*" [tiab] OR "WeChat" [tiab] OR "KakaoTalk" [tiab]  
OR "remote monitor*" [tiab] OR "virtual reality" [tiab] OR "augmented reality" [tiab] OR "VR" [tiab] OR "AR" [tiab]  
OR "artificial intelligence" [tiab] OR "AI" [tiab] OR "machine learning" [tiab] OR "deep learning" [tiab]  
OR "ePRO" [tiab] OR "electronic patient-reported" [tiab] OR "patient reported outcome*" [tiab]))
```

```

OR "internet-based"[tiab] OR "web-based"[tiab] OR "online"[tiab] OR "app-based"[tiab]
OR "sensor*"[tiab] OR "biosensor*"[tiab] OR "digital platform*"[tiab] OR "digital rehabilitation"[tiab]
OR "Internet Plus"[tiab] OR "Internet+ "[tiab])

# Block 3: Multimodal/Multi-component
("multimodal*"[tiab] OR "multi-modal*"[tiab] OR "multi-component*"[tiab] OR "multicomponent*"[tiab]
OR "integrated"[tiab] OR "comprehensive"[tiab] OR "combined"[tiab] OR "blended"[tiab] OR "hybrid"[tiab]
OR "platform*"[tiab] OR "ecosystem*"[tiab] OR "multiple modalit*"[tiab] OR "multiple component*"[tiab])

# Block 4: Study Design Filter
(("Randomized Controlled Trial"[pt] OR "Controlled Clinical Trial"[pt] OR "Clinical Trial"[pt]
OR "Observational Study"[pt] OR "Comparative Study"[pt]
OR "randomized controlled trial*"[tiab] OR "RCT"[tiab] OR "randomised"[tiab] OR "randomized"[tiab]
OR "controlled trial*"[tiab] OR "controlled stud*"[tiab] OR "quasi-experimental"[tiab]
OR "non-randomized"[tiab] OR "nonrandomized"[tiab] OR "comparative stud*"[tiab]
OR "cohort"[tiab] OR "prospective"[tiab] OR "case-control"[tiab])
NOT ("animal"[Mesh] NOT "humans"[Mesh]))

# Final: Block 1 AND (Block 2 OR Block 3) AND Block 4

```

Note: (Block 2 OR Block 3) intentionally used rather than (Block 2 AND Block 3) for sensitivity — multimodal determination occurs at full-text stage.

2. EMBASE (Ovid)

Platform: Ovid

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

1. exp lung tumor/ OR exp non small cell lung cancer/ OR exp small cell lung cancer/
2. (lung cancer* OR lung neoplasm* OR lung carcinoma* OR lung malignanc* OR NSCLC OR SCLC OR pulmonary m
3. 1 OR 2
4. exp lung surgery/ OR exp lobectomy/ OR exp pneumonectomy/
5. (lung surger* OR lung resection* OR pulmonary resection* OR thoracic surger* OR lobectomy OR pneumon
6. 4 OR 5
7. exp perioperative period/ OR exp preoperative care/ OR exp postoperative care/ OR exp enhanced recove
8. (perioperat* OR preoperat* OR postoperat* OR prehabilita* OR rehabilita* OR ERAS OR enhanced recovery
9. 7 OR 8
10. exp digital health/ OR exp telemedicine/ OR exp mobile application/ OR exp wearable device/ OR exp a
11. (digital health* OR digital therap* OR digital intervention* OR digital medic* OR DTx OR mHealth OR
12. (wearable* OR smart watch* OR smartwatch* OR activity track* OR mobile app* OR smartphone app* OR W
13. (artificial intelligence OR AI OR machine learning OR deep learning OR ePRO OR electronic patient-r
14. (multimodal* OR multi-modal* OR multi-component* OR multicomponent* OR integrated OR comprehensive
15. 10 OR 11 OR 12 OR 13 OR 14
16. exp randomized controlled trial/ OR exp controlled clinical trial/ OR exp quasi experimental study/
17. (randomized controlled trial* OR RCT OR randomised OR randomized OR controlled trial* OR controlled
18. 16 OR 17
19. 3 AND 6 AND 9 AND 15 AND 18
20. limit 19 to (human and (english or chinese))

3. Cochrane Library (CENTRAL)

Platform: Wiley

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

```
#1 MeSH descriptor: [Lung Neoplasms] explode all trees
#2 MeSH descriptor: [Carcinoma, Non-Small-Cell Lung] explode all trees
#3 (lung cancer* OR lung neoplasm* OR NSCLC OR SCLC OR pulmonary neoplasm*):ti,ab,kw
#4 #1 OR #2 OR #3

#5 MeSH descriptor: [Thoracic Surgical Procedures] explode all trees
#6 MeSH descriptor: [Pneumonectomy] explode all trees
#7 (lung surger* OR lung resection* OR lobectomy OR pneumonectomy OR segmentectomy OR VATS OR RATS OR
#8 #5 OR #6 OR #7

#9 MeSH descriptor: [Perioperative Care] explode all trees
#10 (perioperat* OR preoperat* OR postoperat* OR prehabilita* OR rehabilita* OR ERAS OR enhanced recover
#11 #9 OR #10

#12 MeSH descriptor: [Digital Health] explode all trees
#13 MeSH descriptor: [Telemedicine] explode all trees
#14 MeSH descriptor: [Mobile Applications] explode all trees
#15 MeSH descriptor: [Wearable Electronic Devices] explode all trees
#16 MeSH descriptor: [Artificial Intelligence] explode all trees
#17 (digital health* OR digital therap* OR mHealth OR eHealth OR telehealth OR telemedicine OR wearable
#18 (multimodal* OR multi-modal* OR multi-component* OR integrated OR comprehensive OR platform* OR mul
#19 #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18

#20 MeSH descriptor: [Randomized Controlled Trial] explode all trees
#21 (RCT OR randomised OR randomized OR quasi-experimental OR non-randomized OR comparative stud* OR co
#22 #20 OR #21

#23 #4 AND #8 AND #11 AND #19 AND #22
```

4. Web of Science (Core Collection)

Platform: Clarivate

Date Coverage: Inception to June 10, 2026

Databases: SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

Population

TS=("lung cancer*" OR "lung neoplasm*" OR "lung carcinoma*" OR "NSCLC" OR "SCLC" OR "pulmonary neoplasm"

Surgery

TS=("lung surger*" OR "lung resection*" OR "pulmonary resection*" OR "thoracic surger*" OR "lobectomy" (

Perioperative

TS=("perioperat*" OR "preoperat*" OR "postoperat*" OR "prehabilita*" OR "rehabilita*" OR "ERAS" OR "enh

Digital Health (broad)

TS=("digital health*" OR "digital therap*" OR "digital intervention*" OR "DTx" OR "mHealth" OR "mobile health")

Multimodal
TS=("multimodal*" OR "multi-modal*" OR "multi-component*" OR "multicomponent*" OR "integrated" OR "comprehensive")

Study Design
TS=("randomized controlled trial*" OR "RCT" OR "randomised" OR "randomized" OR "controlled trial*" OR "clinical trial")

Combine: Population AND Surgery AND Perioperative AND (Digital OR Multimodal) AND Study Design
#1 AND #2 AND #3 AND (#4 OR #5) AND #6

Language: English OR Chinese
Document Types: Article, Early Access, Proceeding Paper, Clinical Trial

5. CINAHL (EBSCOhost)

Platform: EBSCOhost

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

S1 (MH "Lung Neoplasms+") OR TI("lung cancer*" OR "lung neoplasm*" OR "NSCLC" OR "SCLC") OR AB("lung cancer*" OR "lung neoplasm*" OR "NSCLC" OR "SCLC")

S2 (MH "Thoracic Surgery+") OR (MH "Pneumonectomy") OR TI("lung surger*" OR "lung resection*" OR "lobectomy") OR AB("lung surger*" OR "lung resection*" OR "lobectomy")

S3 (MH "Perioperative Care+") OR (MH "Preoperative Care+") OR (MH "Postoperative Care+") OR TI("perioperative care*" OR "preoperative care*" OR "postoperative care*") OR AB("perioperative care*" OR "preoperative care*" OR "postoperative care*")

S4 (MH "Telemedicine+") OR (MH "Mobile Applications") OR (MH "Wearable Sensors+") OR (MH "Artificial Intelligence") OR TI("digital health*" OR "digital therap*" OR "mHealth" OR "eHealth" OR "telehealth" OR "telemedicine") OR AB("digital health*" OR "digital therap*" OR "mHealth" OR "eHealth" OR "telehealth" OR "telemedicine")

S5 TI("multimodal*" OR "multi-modal*" OR "multi-component*" OR "integrated" OR "comprehensive" OR "blended") OR AB("multimodal*" OR "multi-modal*" OR "multi-component*" OR "integrated" OR "comprehensive" OR "blended")

S6 (MH "Randomized Controlled Trials+") OR (MH "Quasi-Experimental Studies+") OR (MH "Comparative Studies") OR TI("RCT" OR "randomised" OR "randomized" OR "quasi-experimental" OR "comparative stud*" OR "cohort study") OR AB("RCT" OR "randomised" OR "randomized" OR "quasi-experimental" OR "comparative stud*" OR "cohort study")

S7 S1 AND S2 AND S3 AND (S4 OR S5) AND S6

Limiters: Language: English, Chinese; Exclude MEDLINE records

6. Scopus

Platform: Elsevier

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

TITLE-ABS-KEY(
("lung cancer*" OR "lung neoplasm*" OR "NSCLC" OR "SCLC")
AND
("lung surger*" OR "lung resection*" OR "lobectomy" OR "pneumonectomy" OR "segmentectomy" OR "VATS" OR "minimally invasive")
AND
("randomized controlled trial*" OR "RCT" OR "randomised" OR "randomized" OR "quasi-experimental" OR "comparative stud*" OR "cohort study")
)

```

("perioperat*" OR "preoperat*" OR "postoperat*" OR "ERAS" OR "enhanced recovery")
AND
(
  "digital health*" OR "digital therap*" OR "mHealth" OR "eHealth" OR "telehealth" OR "telemedicine"
  OR "wearable*" OR "mobile app*" OR "smartphone app*" OR "WeChat" OR "remote monitor*"
  OR "virtual reality" OR "artificial intelligence" OR "AI" OR "machine learning" OR "ePRO"
  OR "electronic patient-reported" OR "digital platform*" OR "digital rehabilitation" OR "telerehabil."
  OR "multimodal*" OR "multi-modal*" OR "multi-component*" OR "multicomponent*" OR "integrated" OR "c
)
AND
("RCT" OR "randomised" OR "randomized" OR "quasi-experimental" OR "non-randomized" OR "comparative st
)
AND (LIMIT-TO(LANGUAGE, "English") OR LIMIT-TO(LANGUAGE, "Chinese"))
AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "cp") OR LIMIT-TO(DOCTYPE, "ch"))

```

7. IEEE Xplore

Platform: IEEE

Date Coverage: Inception to June 10, 2026

Note: Focused on wearable/sensor/AI aspects; simplified search due to platform constraints

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

```

("Document Title":"lung cancer" OR "Document Title":"thoracic surgery" OR "Document Title":"perioperative"
OR
("Abstract":"lung cancer" OR "Abstract":"thoracic surgery" OR "Abstract":"perioperative")
AND
("Abstract":"wearable" OR "Abstract":"mobile app" OR "Abstract":"smartphone" OR "Abstract":"remote moni
OR "Abstract":"digital health" OR "Abstract":"sensor" OR "Abstract":"biosensor" OR "Abstract":"ePRO"
OR "Abstract":"artificial intelligence" OR "Abstract":"machine learning")
AND
("Abstract":"surgery" OR "Abstract":"surgical" OR "Abstract":"perioperative" OR "Abstract":"postoperati

```

8. CNKI ()

Platform: CNKI

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

```

#      ( )
SU=(' '+' '+' '+' '+'NSCLC')
AND
SU=(' '+' '+' '+' '+'VATS'+' '+'RATS'+' '+' '+' '+' '+'ERAS')
AND
SU=(' '+' '+' '+' '+' '+' '+' '+' '+' '+' '+'
+' '+' '+' '+' '+'APP'+' '+' '+'
+' '+'ePRO'+' '+'VR'+' '+'AR'
+' '+' '+' '+' '+' ')
AND
SU=(' '+'RCT'+' '+' '+' '+' '+' '+' ')

```

9. Wanfang Data ()

Platform: Wanfang Data

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

```
#
:(" " OR " " OR "NSCLC")
AND
:(" " OR " " OR " " OR " " OR "VATS" OR " " OR " " OR " ")
AND
:(" " OR " " OR " " OR " " OR " " OR " " OR "APP" OR " " OR " " OR " " OR "ePRO" OR " "
AND
:(" " OR " " OR "RCT" OR " " OR " " OR " " OR " ")
```

10. CBM ()

Platform: CBM

Date Coverage: Inception to June 10, 2026

Results: Pending author/institution export verification; do not estimate. See 1_Search/search_strategies_submission_n

```
# CBM +
#
((" "[ : ]) OR " "[ : ])

#
((" "[ : ]) OR " "[ : ] OR " "[ : ] OR " "[ : ])

#
((" "[ : ]) OR " "[ : ] OR " "[ : ] OR " "[ : ])

#
(" "[ : ] OR " "[ : ] OR " "[ : ] OR " "[ : ] OR " "[ : ] OR " "[ : ] OR "APP"[ : ] OR "

#
(" "[ : ] OR "RCT"[ : ] OR " "[ : ] OR " "[ : ] OR " "[ : ])
```

Trial Registries

ClinicalTrials.gov

(lung cancer OR NSCLC OR pulmonary neoplasm)

AND (digital OR mobile OR wearable OR app OR telehealth OR telemedicine OR ePRO OR remote monitoring OR

AND (perioperative OR surgery OR resection OR lobectomy OR pneumonectomy)

| First posted from inception to 06/10/2026

ChiCTR ()

AND (OR OR OR OR OR ePRO OR OR APP)

EU Clinical Trials Register

lung cancer AND (digital OR mobile OR wearable OR app OR telehealth) AND (surgery OR perioperative OR r

ANZCTR

lung cancer AND (digital OR mobile OR wearable OR telehealth OR ePRO) AND (surgery OR perioperative OR :

WHO ICTRP

Combined search across all registries using ClinicalTrials.gov syntax.

Grey Literature Sources

Source	Search Method	Date Coverage
ATS International Conference	Manual screening of abstract books	2023–2026
ESTS Annual Meeting	Manual screening of abstract books	2023–2026
IASLC WCLC	Manual screening of abstract books	2023–2026
ASCO Annual Meeting	Manual screening of abstract books	2023–2026
ESMO Congress	Manual screening of abstract books	2023–2026
ICCN	Manual screening of abstract books	2023–2026
Reference lists	Backward citation of included studies + Lu 2024, He 2024	—
Google Scholar	Top 100 results by relevance (simplified search)	—

PRISMA-S Reporting Checklist

- ☒ Database name and platform specified for each source
- ☒ Full search strategy for each database
- ☒ Date range for each search
- ☒ Date search was conducted
- ☒ Any limits or filters applied
- ☒ Grey literature sources with search methods
- ☒ Trial registry search strategies
- ☐ Results counts (to be filled after execution)

1_Search/search_strategies_submission_notes.md

Search Count Submission Notes

Database hit counts that still require author/institution export verification are listed below.

- PubMed: exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- EMBASE (Ovid): exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- Cochrane Library (CENTRAL): exact hit count not finalized in workspace; fill from formal search export or database screenshot.

- Web of Science (Core Collection): exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- CINAHL (EBSCOhost): exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- Scopus: exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- IEEE Xplore: exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- CNKI (): exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- Wanfang Data (): exact hit count not finalized in workspace; fill from formal search export or database screenshot.
- CBM (): exact hit count not finalized in workspace; fill from formal search export or database screenshot.

1_Search/expanded_search_2026-06-13/expanded_search_plan_and_results.md

Expanded Search Plan and Results

Date executed: 2026-06-13

Purpose: Increase sensitivity because the final included evidence base is small. The population, perioperative lung cancer surgery context, and multimodal digital health intervention requirement were retained. Study design was broadened from RCT/quasi-experimental emphasis to include non-randomized controlled clinical studies, controlled before-after designs, and comparative cohorts. Single-arm studies were not added unless the user later explicitly broadens design further.

Skills and Tools Used

- **paper-lookup:** used as the discovery framework for PubMed, OpenAlex, Semantic Scholar, PMC ID conversion, and ClinicalTrials.gov API retrieval.
- **scansci-pdf:** prioritized by project rules, but no `scansci-pdf_*` MCP tools were exposed in the current session; marked as unavailable for this execution.
- **paper-fetch:** used as fallback PDF downloader for priority DOI records.
- **pdf:** used for PDF validation and full-text/JATS text extraction.
- Local script: `scripts/expanded_search_2026_06_13.py`.

Search Sources

Source/query	Raw file	Count/returned
PubMed broad design query	<code>results_raw/pubmed_broad_design_esearch.json</code>	519 hits; top 200 retrieved
PubMed symptom/ePRO query	<code>results_raw/pubmed_symptom_epro_esearch.json</code>	45 hits; 45 retrieved
PubMed rehab/tele query	<code>results_raw/pubmed_rehab_tele_esearch.json</code>	42 hits; 42 retrieved
OpenAlex rehab query	<code>results_raw/openalex_rehab.json</code>	86 hits; top 50 retrieved
OpenAlex symptom query	<code>results_raw/openalex_symptom.json</code>	150 hits; top 50 retrieved
OpenAlex broad query	<code>results_raw/openalex_broad.json</code>	0
OpenAlex Chinese terms query	<code>results_raw/openalex_chinese_terms.json</code>	0
Semantic Scholar broad/rehab	<code>results_raw/s2_*.json</code>	HTTP 429, recorded
ClinicalTrials.gov digital lung surgery	<code>results_raw/ctg_digital_lung_surgery.json</code>	100 records returned

Source/query	Raw file	Count/returned
ClinicalTrials.gov rehab app	results_raw/ctg_lung_rehab_app.json	0

After de-duplication, 455 unique candidate records were saved in `candidate_records.tsv`.

Screening Output

Primary files:

- Candidate table: `1_Search/expanded_search_2026-06-13/candidate_records.tsv`
- Title/abstract expanded screen: `2_Screening/expanded_2026-06-13/ta_screening_expanded.tsv`
- Full-text expanded screen: `2_Screening/expanded_2026-06-13/full_text_screening_expanded.tsv`
- Extracted candidate data: `3_Extraction/expanded_candidate_extraction_2026-06-13.tsv`
- Manual PDF list: `2_Screening/expanded_2026-06-13/manual_pdf_needed_expanded.md`

Priority Full-Text Findings

Record	Decision	Rationale
EXP008 Lee 2024 JAMA Network Open	Include in expanded NRSI pool, pending final PDF lock	Nonrandomized historical-control clinical trial; wearable monitoring + remote counseling + exercise prescription. Full-text JATS XML retrieved; PDF auto-download failed.
EXP260 Tang/Wang 2026 Medicine	Include in expanded NRSI pool with caution, pending final PDF lock	Retrospective matched controlled study; Dignio remote care platform + connected devices + rehab program. Full-text JATS XML retrieved; PDF auto-download failed. Outcome denominators vary greatly.
EXP224 Sui 2020 EJON	Pending full-text PDF	Likely eligible WeChat education/rehabilitation RCT; abstract includes extractable HADS and QLQ-C30 data, but full PDF is required before final inclusion.
EXP249 Patel 2023 BJS Move For Surgery	Pending full-text PDF	Likely eligible wearable-enhanced preconditioning RCT; full PDF required before extraction.
EXP108 Chen 2024 Alternative Therapies	Pending full-text PDF and modality check	Retrospective comparative pedometer-based rehab study; full text needed to confirm whether it meets multimodal DHI threshold.
EXP152 Chen 2026 Biological Research for Nursing	Pending full-text PDF and modality check	RCT of intelligent breathing training digital device; full text needed to confirm whether this is more than single digital modality.

Record	Decision	Rationale
EXP253 Kadiri 2019 J Cardiothorac Surg	Exclude or SWiM/background only	PDF downloaded, but mixed population and clinical outcomes are largely single-arm; not a clean controlled effectiveness study.
EXP242 Pehlivan 2025	Exclude	Teleconference exercise only; single-modality telerehabilitation.
EXP257 Shin 2026	Exclude	Messenger/telephone telerehabilitation only; same rationale as prior KakaoTalk exclusion.
EXP129 Finch 2025	Exclude	Single-arm before-after prehabilitation; no controlled comparator.
EXP095 Cheng 2021	Exclude	Single-arm observational WeChat recovery monitoring.
EXP202 Sewell 2025	Exclude	Implementation/response-status cohort, not assigned intervention vs usual care; mixed thoracic surgery population.
EXP259 Li 2025 CNLC	Exclude	Single-arm AI platform application study; no comparator.
EXP082 Mangiameli 2024	Exclude unless scope broadened	Digital early-discharge safety pathway, not clearly the review's rehab/symptom-management DHI scope.

Current Recommendation Superseded by Unified Review Update

This file records the supplementary gap-fill search as it was performed. The earlier recommendation to keep a separate five-study primary dataset has been superseded.

Current interpretation:

- The supplementary search is a gap-fill/correction step for the same systematic review.
- Eligible RCTs from this search are integrated into the unified RCT evidence base.
- Eligible nonrandomized controlled studies are integrated into the final qualitative/SWiM evidence base.
- NRSI studies are not pooled with RCTs.
- Current authority files are 3_Extraction/final_extraction_unified_clean.csv, 4_Analysis/analysis_main.R, and 4_Analysis/analysis_output/MASTER_RESULTS_TABLE.txt.

qc/search_screening_audit_log.md

Search and Screening Audit Log

Project: Multimodal DHI vs standard perioperative management in lung cancer surgery

Current final status: unified evidence base with 11 controlled studies, 2,088 participants (8 RCTs and 3 nonrandomized controlled studies). The original search and supplementary gap-fill search are integrated into one PRISMA/screening/extraction/analysis workflow. Shuang 2024, Wang 2026, and Wang WeChat N=96 remain excluded after user manual full-text review.

Interpretive note: Sections below preserve the chronological audit trail, including earlier “expanded” labels used during the gap-fill phase. Those labels are historical process terms only. The current submission-facing

interpretation is the unified 11-study evidence base.

Search Documentation

Component	File	Status	Notes
Full database strategies	1_Search/search_strategies.md	Final strategy text recorded	Some database hit counts remain [TO BE FILLED]; user/database exports are needed for exact PRISMA counts
Update search raw records	1_Search/update_search_results_PubMed_2026-06-12/	Archived	PubMed, PMC, OpenAlex, ClinicalTrials.gov, EuropePMC, Frontiers page payloads
Trial registry follow-up	2_Screening/pending_records_2026-06-12/	Completed from 2026 pending records	NCT05990946 awaiting results; NCT07310056 ongoing/no results; NCT06600503 protocol only
Full-text download log	2_Screening/full_text_download_log.md	Partial download log	Documents scansci-pdf skill plan and fallback web/API retrieval attempts
Full-text manifest	2_Screening/full_text_manifest.csv	Complete	All final included studies have local PDF and SHA256

Search Count Status

Source	Exact hit count available?	Current handling
PubMed update	Raw XML archived	Can be counted from raw XML if final exact update count is required
ClinicalTrials.gov tracked records	Yes for named records	Three named trial records archived and resolved
OpenAlex/EuropePMC targeted updates	JSON/XML archived	Used for targeted gap-fill, not a full database PRISMA count
Embase/Ovid	No export in workspace	Strategy recorded; user should export if exact count required
Cochrane CENTRAL	No export in workspace	Strategy recorded; user should export if exact count required
Web of Science	No export in workspace	Strategy recorded; user should export if exact count required
CINAHL	No export in workspace	Strategy recorded; user should export if exact count required

Source	Exact hit count available?	Current handling
Scopus	No export in workspace	Strategy recorded; user should export if exact count required
CNKI/Wanfang/CBM/WuJi	No export in workspace	Strategy recorded and Chinese candidates manually adjudicated

Screening Documentation

Stage	File	Role	Current authority
Round 1 title/abstract	2_Screening/round1_title_abstract_screen	Historical screening	Superseded by round4 final decisions
Round 2 dual screen	2_Screening/round2_dual_screening	Historical screening second screen	Superseded by round4 final decisions
Round 3 adjudication	2_Screening/round3_adjudication	Historical adjudication	Superseded by round4 final decisions
Round 4 full-text screen	2_Screening/round4_fullscreening	Primary screening authority inclusion/exclusion	
Pending resolution	2_Screening/pending_resolution	Final resolution trial/candidate records	2026-06-12 dtsg

Final Included Studies

Study	Final decision	Evidence
Xu 2025	Include	OA PDF retrieved; DTx vs MM RCT
Lv 2025 POPPER	Include	OA PDF retrieved; smartphone app RCT
Li 2025	Include	OA PDF retrieved; app + wearable + AI exercise RCT
Dai/Jing 2025	Include	OA PDF retrieved; WeChat ePRO RCT
Jiang 2024	Include	User-provided PDF retrieved; WeChat mini-program RCT

Final Excluded/Pending Records

Record	Final decision	Reason/source
Shuang 2024	Exclude	User manual full-text review, 2026-06-12
Wang 2026	Exclude	User manual full-text review, 2026-06-12
Wang WeChat respiratory N=96	Exclude	User manual full-text review, 2026-06-12
NCT05990946	Awaiting results	No result paper located; tracked in pending-resolution table
NCT07310056	Ongoing/no results	ClinicalTrials.gov status checked

Record	Final decision	Reason/source
NCT06600503	Protocol only	PubMed protocol and registry checked

PRISMA Caution

The manuscript currently uses approximate overall search counts. For journal submission, exact PRISMA counts should be finalized from database exports. The study-level inclusion/exclusion decisions are documented, but exact database hit counts for subscription databases are not present in the workspace.

Expanded Search 2026-06-13

User requested another search because the included evidence base was small and allowed broadening to non-randomized controlled clinical studies.

Scope used: - Population/intervention/outcome scope retained: perioperative lung cancer surgery and multimodal digital health intervention. - Study design broadened to RCTs, nonrandomized controlled trials, retrospective/prospective controlled studies, historical-control studies, and comparative cohorts. - Single-arm studies were not newly included. - Previously user-excluded Shuang 2024, Wang 2026, and Wang WeChat respiratory N=96 were not reintroduced.

Files created:

File	Role
scripts/expanded_search_2026_06_13.py	Reproducible API search script
1_Search/expanded_search_2026-06-13/expanded_search_queries_and_results	Expanded search queries and results
1_Search/expanded_search_2026-06-13/results_raw	Raw PubMed/OpenAlex/ClinicalTrials.gov/PMC/JATS/landing-page records
1_Search/expanded_search_2026-06-13/candidate_records	455 records of duplicated candidate records
2_Screening/expanded_2026-06-13/ta_screening_expanded_title	Expanded title/abstract screening table
2_Screening/expanded_2026-06-13/full_text_screening_expanded_title	Expanded title/abstract screening decisions
2_Screening/expanded_2026-06-13/manual_pdf_needed_expanded_title	Manual PDF needed list
3_Extraction/expanded_candidate_extraction_2026-06-13_text	2026-06-13 text extraction notes for potentially addable studies

Search counts from open sources:

Source/query	Count	Retrieved
PubMed broad design	579	200
PubMed symptom/ePRO	45	45
PubMed rehab/tele	42	42
OpenAlex rehab	86	50
OpenAlex symptom	150	50
OpenAlex broad	0	0
OpenAlex Chinese terms	0	0
Semantic Scholar broad/rehab	HTTP 429	0
ClinicalTrials.gov digital lung surgery	returned 100	100
ClinicalTrials.gov lung rehab app	0	0

Priority decisions:

Record	Decision	Note
EXP008 Lee 2024 JAMA Network Open	Expanded NRSI include candidate	JATS full text retrieved; PDF still needed
EXP260 Tang/Wang 2026 Medicine	Expanded NRSI include candidate with caution	JATS full text retrieved; PDF still needed; follow-up denominators vary
EXP224 Sui 2020 EJON	Pending full-text PDF	Likely eligible WeChat education/rehab RCT
EXP249 Patel 2023 BJS	Pending full-text PDF	Likely eligible wearable-enhanced preconditioning RCT
EXP108 Chen 2024 Alt Ther	Pending PDF and modality confirmation	Retrospective pedometer rehab comparator study
EXP152 Chen 2026 Biol Res Nurs	Pending PDF and modality confirmation	RCT; may be single digital device
EXP242 Pehlivan 2025	Exclude	Single-modality telerehabilitation
EXP257 Shin 2026	Exclude	Single-modality messenger/telephone telerehabilitation
EXP129 Finch 2025	Exclude	Single-arm before-after
EXP095 Cheng 2021	Exclude	Single-arm observational monitoring
EXP202 Sewell 2025	Exclude	Response-status implementation cohort, not assigned intervention control
EXP259 Li 2025 CNLC	Exclude	No comparator

PDF retrieval status: - `scansci-pdf` was the preferred skill/MCP route. In the later full-text follow-up, the local MCP server was started by `stdio` and `scansci_pdf_download` was called directly. - Fallbacks used: PMC ID conversion, PMC JATS efetch, DOI landing pages, publisher direct links, and `paper-fetch`. - `paper-fetch` successfully downloaded Kadir 2019 Fit 4 Surgery PDF, but that study is not a clean controlled effectiveness study and is not recommended for primary inclusion. - For priority addable records, manual/ institutional PDF retrieval remains needed before any final data lock.

Historical impact note at the time of this step: - No change was initially made to `3_Extraction/final_extraction_locked_c`. - The five-RCT dataset was temporarily retained while PDFs were pending. - This boundary has since been superseded by the unified 11-study evidence base after PDF verification.

Full-Text PDF Download Follow-Up 2026-06-13

User clarified that `scansci_pdf_download` should be run with `scihub_enabled=true` and that obtaining full text should be the first priority.

Actions performed:

Step	Tool/skill	Details	Output
1	scansci-pdf skill + local MCP	Started scansci-pdf run --mode stdio; called scansci_pdf_download with strategy="fastest", scihub_enabled=true, use_tor=false, use_vpnscli=false, bibtex=true	Run entered Sci-Hub/LibGen path but clearnet mirrors failed/blocked; internal Tor fallback stalled because Tor bundle download timed out
2	scansci-pdf diagnostics	Checked scansci_pdf_camofox_status config, auto setup, Tor start	camofox-browser service localhost:9377 unreachable; Tor download from dist.torproject.org and archive.torproject.org timed out
3	paper-fetch skill	Ran batch fallback with Sci-Hub enabled by default	2_Screening/expanded_2026-06-13/paper_fetch.log no target PDF succeeded
4	paper-lookup skill	PubMed eSummary and Crossref title search for EXP108	PubMed confirmed no DOI, PII AT9085; Crossref found no exact DOI
5	Direct publisher checks	Tried EXP108 official OA URL https://alternative-theories.com/oa/pdf/9085.pdf	URL identified but CLI download timed out; https://alternative-theories.com/oa/pdf/9085.pdf transferred

Result: - No new PDF was successfully downloaded for EXP008, EXP224, EXP249, EXP260, EXP108, or EXP152. - EXP008 and EXP260 still have full-text JATS XML available for content verification, but PDF remains missing. - EXP108 now has a precise official OA manual target URL. - Updated manual request list: 2_Screening/expanded_2026-06-13/manual_pdf_needed_expanded.md. - Added detailed status files: 2_Screening/expanded_2026-06-13/fulltext_pdf_download_status_2026-06-13.md and .tsv.

Manual PDF Supplement and Full-Text Verification 2026-06-13

User later supplied the six high-value full-text PDFs that had not been obtained by automated retrieval. The pdf skill was used for local PDF verification/text extraction. PDFs were archived in 2_Screening/pdfs/expanded_2026-06-13/ and text was extracted to 2_Screening/expanded_2026-06-13/pdf_text_full/

Verified PDFs:

ID	Study	Archived PDF	Decision after PDF review
EXP008	Lee 2024 JAMA Network Open	EXP008_Pmid39302678_Lee2024_JAMA	Insufficient NRSI/SWiM evidence
EXP224	Sui 2020 EJON	EXP224_Pmid32078926_Sui2020_EJON	Insufficient RCT evidence
EXP249	Patel 2023 BJS	EXP249_Pmid37643916_Patel2023_BJS	Insufficient RCT evidence

ID	Study	Archived PDF	Decision after PDF review
EXP260	Tang/Wang 2026 Medicine	EXP260_PMD42175423_Tang2026_Medicine.pdf	2026-06-13 NRSI/SWiM evidence with caution
EXP108	Chen 2024 Alternative Therapies	EXP108_PMD37820671_Chen2024_Alternative.pdf	2026-06-13 NRSI/SWiM evidence with caution
EXP152	Chen 2026 Biological Research for Nursing	EXP152_PMD41506643_Chen2026_BiologicalResearchForNursing.pdf	2026-06-13 NRSI/SWiM evidence

Files updated:

File	Update
2_Screening/expanded_2026-06-13/full_text_screening_expanded_full	2026-06-13 Replaced full-text statuses with PDF-verified inclusion decisions
3_Extraction/expanded_candidate_extraction_2026-06-13	2026-06-13 Replaced PDF-confirmed expanded extraction table with RCT/NRSI status and extractability notes
3_Extraction/expanded_pdf_fulltext_verification_2026-06-13	2026-06-13 Replaced verification and extraction evidence summary
2_Screening/expanded_2026-06-13/fulltext_pdf_downloads_statuses_2026-06-13 and .tsv	2026-06-13 Manual status high-2026-06-13 PDFs manually obtained, archived and verified
2_Screening/expanded_2026-06-13/manual_pdf_needed_expanded	2026-06-13 Manual PDF targets completed

Superseded analytic boundary: at this step 3_Extraction/final_extraction_locked_clean.csv was not modified. After the user's later request to unify the two searches, eligible verified studies were integrated into 3_Extraction/final_extraction_unified_clean.csv and the main analysis was rerun.

Expanded RCT Sensitivity Analysis 2026-06-13

Historical step: after PDF verification, an independent sensitivity analysis was first run without modifying 4_Analysis/analysis_main.R or 3_Extraction/final_extraction_locked_clean.csv. This was later superseded by the unified analysis_main.R.

New input files:

File	Role
3_Extraction/expanded_rct_sensitivity_dataset_2026-06-13.csv	2026-06-13 Temporary continuous RCT dataset
3_Extraction/expanded_rct_dichotomous_dataset_2026-06-13.csv	2026-06-13 Temporary dichotomous RCT dataset
4_Analysis/analysis_expanded_sensitivity_2026-06-13.R	2026-06-13 Initial temporary R script later superseded by unified analysis_main.R

Command run:

Rscript 4_Analysis/analysis_expanded_sensitivity_2026_06_13.R

Outputs:

File	Role
4_Analysis/expanded_2026-06-13/expanded_sensitivity_results.md	Historical sensitivity result summary
4_Analysis/expanded_2026-06-13/expanded_continuum_model_results.csv	Model model results
4_Analysis/expanded_2026-06-13/expanded_continuum_effects.csv	Study effect continuous effects
4_Analysis/expanded_2026-06-13/expanded_dichotomous_effects.csv	Study effect dichotomous RR effects
4_Analysis/expanded_2026-06-13/forest_expanded_pulmonary-function_forest_plot	Expanded pulmonary-function forest plot
4_Analysis/expanded_2026-06-13/forest_expanded_hrqol_forest_plot	Expanded HRQoL forest plot
4_Analysis/expanded_2026-06-13/forest_expanded_hospital_los_forest_plot	Expanded LOS forest plot
6_Tables/table2_expanded_sensitivity_results_2026-06-13.md	Historical temporary results table
6_Tables/table1_expanded_study_characteristics_2026-06-13.csv	2026-06-13 set of newly PDF-verified expanded studies
6_Tables/S5_expanded_nrsi_swim_2026-06-13.md	Nonrandomized SWiM/narrative evidence table

Historical temporary RCT results later incorporated into the unified analysis:

Outcome	k	N	Effect	Estimate [95% CI]	I ²	Interpretation
Pulmonary function	3	345	SMD	0.705 [0.137, 1.272]	83.9%	Direction favors in- tervention; high het- erogeneity
HRQoL	4	438	SMD	0.647 [0.276, 1.018]	67.9%	Direction favors in- tervention; ex- ploratory
Hospital LOS	2	242	MD days	-0.804 [-2.542, 0.934]	89.6%	Direction favors shorter stay but CI crosses no effect

Single-study dichotomous effects later incorporated into the unified analysis:

- Sui 2020 anxiety rate: RR 0.463 [0.290, 0.740].
- Sui 2020 depression rate: RR 0.556 [0.347, 0.890].
- Patel 2023 prolonged hospital stay >5 days: RR 0.278 [0.084, 0.922].
- Patel 2023 intraoperative complications: RR 0.185 [0.023, 1.480].
- Patel 2023 adverse events during admission: RR 0.725 [0.435, 1.208].

Unified Integration Decision 2026-06-13

After user review, the supplementary search is no longer treated as a separate expanded evidence base. It is a gap-fill/correction step for the same systematic review.

Current final authority:

Domain	Authority file
Final full-text screening	2_Screening/round4_ft_screening.tsv

Domain	Authority file
Unified extraction	3_Extraction/final_extraction_unified_clean.csv
Main R analysis	4_Analysis/analysis_main.R
Main result output	4_Analysis/analysis_output/MASTER_RESULTS_TABLE.txt
Study characteristics	6_Tables/table1_study_characteristics.csv
Meta/SWiM results	6_Tables/table2_meta_results.md
RoB detail	6_Tables/S4_rob_detail.md
NRSI SWiM table	6_Tables/S5_expanded_nrsi_swim_2026-06-13.md
Manuscript	7_Manuscript/manuscript_v1.md

Final included evidence:

- 11 controlled studies, 2,088 participants.
- 8 RCTs contribute to quantitative/descriptive RCT evidence.
- 3 nonrandomized controlled studies contribute to SWiM/ROBINS-I narrative evidence only.
- RCT and NRSI evidence must remain design-stratified; NRSI studies are not pooled with RCTs.

The earlier separate-analysis boundaries are superseded for submission-facing documents.