ESM 5. Meta-analysis, GRADE Evidence Profile, Sensitivity Analyses, and Supplementary Figures

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]

Unified Meta-Analysis and SWiM Results

Generated: 2026-06-13
Software: R 4.4.3, metafor 5.0-1
Scope: initial search plus supplementary gap-fill search integrated as one review. Final included controlled evidence: 11 studies, 2,088 participants (8 RCTs, 1,294 randomized/enrolled; 3 nonrandomized controlled studies, 794 participants).

Table 2. Unified Summary Results

Outcome	Design/data set	k	N	Effect measure	Estimate [95% CI]	I2	Status	GRADE
Pulmonary function	RCT mean/SD synthesis	3	345	SMD (Hedges' g)	0.705 [0.137, 1.272]	83.9%	Exploratory pooled	Very low
Pulmonary function + Lv median/IQR conversion	RCT sensitivity	4	481	SMD (Hedges' g)	0.607 [0.198, 1.016]	78.8%	Sensitivity only	Very low
HRQoL	RCT mean/SD synthesis	4	438	SMD (Hedges' g)	0.647 [0.276, 1.018]	67.9%	Exploratory pooled	Very low
Hospital LOS	RCT mean/SD synthesis	2	242	MD days	-0.804 [-2.542, 0.934]	89.6%	Exploratory pooled	Very low
PPCs	RCT/NRSI source audit	0	0	RR	NA	NA	SWiM; no Clavien-Dindo PPC endpoint available	Insufficient

Outcome	Design/data set	k	N	Effect measure	Estimate [95% CI]	I2	Status	GRADE
Pain intensity	RCT descriptive	1	136	SMD descriptive	-0.206 (SE 0.172)	NA	Not pooled; incompatible reporting formats	Low/insufficient
Anxiety rate	RCT single-study	1	200	RR	0.463 [0.290, 0.740]	NA	Single-study effect	Low/insufficient
Depression rate	RCT single-study	1	200	RR	0.556 [0.347, 0.890]	NA	Single-study effect	Low/insufficient
Prolonged hospital stay >5 days	RCT single-study	1	95	RR	0.278 [0.084, 0.922]	NA	Single-study effect	Low/insufficient
Nonrandomized controlled evidence	3 NRSI	3	794	SWiM/ROBINS-I	Narrative only	NA	Not pooled with RCTs	Very low

Source Data Used in Unified RCT Models

Study	Outcome instrument	Intervention value	Control value	Effect	SE	Source
Xu 2025	FEV1% predicted	87.18 +/- 11.01 (n=72)	84.21 +/- 11.75 (n=75)	0.259	0.166	PDF verified
Jiang 2024	PaO2	96.68 +/- 7.92 (n=30)	87.69 +/- 5.50 (n=30)	1.301	0.284	PDF verified
Chen 2026	FEV1	2.92 +/- 0.49 (n=68)	2.60 +/- 0.47 (n=70)	0.663	0.175	PDF verified
Lv 2025	PFRR	79.32 (73.13-84.97)	75.73 (68.35-82.48)	0.373	0.173	Median/IQR conversion sensitivity only
Li 2025	EORTC QLQ-C30 global health change	16.25 +/- 23.02 (n=22)	1.04 +/- 13.90 (n=18)	0.765	0.329	PDF verified
Jiang 2024	EORTC QLQ-30 total	90.55 +/- 11.32 (n=30)	83.05 +/- 14.09 (n=30)	0.579	0.264	PDF verified

Study	Outcome instrument	Intervention value	Control value	Effect	SE	Source
Sui 2020	EORTC QLQ-C30 global health status	74.44 +/- 12.06 (n=100)	70.26 +/- 17.29 (n=100)	0.279	0.142	PDF verified
Chen 2026	WHOQOL-100 physical domain	78.60 +/- 6.90 (n=68)	71.20 +/- 7.30 (n=70)	1.036	0.181	PDF verified
Xu 2025	LOS	3.85 +/- 0.99 (n=72)	3.84 +/- 1.07 (n=75)	0.010 days	0.170	PDF verified
Patel 2023	LOS	2.67 +/- 1.61 (n=45)	4.44 +/- 3.48 (n=50)	-1.770 days	0.548	PDF verified

Nonrandomized Controlled Studies Included in SWiM

Study	Design	N	Main signal	Reason not pooled
Lee 2024	Nonrandomized historical-control clinical trial	194	Higher daily steps/MVPA and less dyspnea after wearable-supported exercise	Historical-control design and confounding risk
Tang/Wang 2026	Retrospective matched controlled study	500	Remote platform enabled pulmonary-function monitoring and emergent complication detection	Sparse and variable pulmonary-function follow-up denominators
Chen 2024	Retrospective comparative study	100	Better post-intervention FEV1/FVC and shorter postoperative hospitalization	Borderline digital multimodality and high selection/measurement bias risk

Audit Decisions

- The supplementary gap-fill search is treated as an update to the same review, not a separate evidence base.
- Quantitative meta-analysis is design-stratified and restricted to RCTs with source-verifiable compatible data.
- Nonrandomized controlled studies are included in the final qualitative/SWiM synthesis but not pooled with RCTs.
- Shuang 2024, Wang 2026, and Wang WeChat respiratory N=96 remain excluded after user full-text review.

Supplementary Table S5: GRADE Evidence Profile

Outcome	k	N	Study design	Final certainty	Summary estimate	Main reasons for rating
Pulmonary function, primary mean/SD synthesis	3	345	RCTs	Very low	SMD 0.705 [0.137, 1.272]	Open-label designs, high heterogeneity, imprecision, indirectness from mixed pulmonary measures
Pulmonary function, Lv median/IQR conversion sensitivity	4	481	RCTs	Very low	SMD 0.607 [0.198, 1.016]	Conversion uncertainty, high heterogeneity, imprecision
HRQoL	4	438	RCTs	Very low	SMD 0.647 [0.276, 1.018]	Open-label PRO outcome, heterogeneity of instruments and time points, imprecision
Hospital LOS	2	242	RCTs	Very low	MD -0.804 days [-2.542, 0.934]	Exploratory k=2 synthesis, high heterogeneity, imprecision
PPCs	0	0	RCT/NRSI source audit	Insufficient	Not pooled	No included study had extractable Clavien-Dindo PPC counts
Pain intensity	1	136	RCT	Low/insufficient	Lv 2025 Hedges g -0.206 (SE 0.172)	Only one compatible mean/SD study; other studies used incompatible formats

Outcome	k	N	Study design	Final certainty	Summary estimate	Main reasons for rating
Anxiety rate	1	200	RCT	Low/insufficient	RR 0.463 [0.290, 0.740]	Single-study effect; open-label PRO endpoint
Depression rate	1	200	RCT	Low/insufficient	RR 0.556 [0.347, 0.890]	Single-study effect; open-label PRO endpoint
Prolonged hospital stay >5 days	1	95	RCT	Low/insufficient	RR 0.278 [0.084, 0.922]	Single-study effect and outcome-specific analysis set
Nonrandomized controlled evidence	3	794	NRSI	Very low	SWiM narrative only	Serious confounding, selection bias, and missing/variable follow-up denominators