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EFFECTIVENESS OF RESPIRATORY EXERCISE AND ABDOMINAL STRENGTH TRAINING PROGRAMME ON PAIN AND ABDOMINAL MUSCLE STRENGTH IN POST-OPERATIVE PATIENTS WITH ABDOMINAL SURGERIES: A SYSTEMATIC REVIEW

Physiotherapy

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ABSTRACT

Postoperative pulmonary complications (PPCs) are a significant cause of morbidity and mortality following abdominal surgery, particularly upper abdominal procedures. This systematic review evaluates the effectiveness of physical therapy interventions, including inspiratory muscle training (IMT), deep breathing exercises, and early mobilization, in reducing PPCs and improving respiratory outcomes. A comprehensive analysis of randomized controlled trials (RCTs), observational studies, and clinical guidelines reveals that structured physiotherapy programs, particularly those incorporating IMT, significantly reduce PPCs, enhance diaphragmatic function, and shorten hospital stays. However, heterogeneity in study designs and outcome measures highlights the need for standardized protocols. This review synthesizes current evidence to guide clinical practice and future research.

KEYWORDS

INTRODUCTION

Upper abdominal surgery is associated with a high incidence of PPCs, including atelectasis, pneumonia, and respiratory failure, due to diaphragmatic dysfunction, reduced lung volumes, and impaired mucociliary clearance (Huang et al., 2022; Rothman et al., 2014). Physiotherapy interventions, such as IMT, breathing exercises, and early mobilization, aim to mitigate these risks by improving respiratory muscle strength and lung function. Despite their widespread use, the efficacy of these interventions remains debated due to inconsistent evidence (Patman S et. al 2017, Hanekom et al., 2012). This review examines the impact of physiotherapy on PPCs, respiratory function, and patient outcomes following abdominal surgery.

Although existing studies have contributed valuable insights, their scope remains limited regarding the effectiveness of respiratory exercises and abdominal strength training on pain and abdominal muscle strength in post-operative patients following open abdominal surgeries. To justify incorporating abdominal muscle strengthening exercises alongside regular respiratory exercises in this population, it is essential to establish their efficacy with minimal risk of harm. This review evaluates the available literature to determine whether such interventions are warranted. Accordingly, the aim of this study was to systematically review and synthesize evidence on the impact of respiratory exercises and abdominal muscle strength training on pain and muscle strength in patients recovering from open abdominal surgeries.

METHODS

Search Strategy

A comprehensive systematic search was conducted across three major electronic databases—PubMed, EMBASE, and Cochrane Library—to identify relevant studies published between 2008 and 2022. The search strategy incorporated a combination of Medical Subject Headings (MeSH) terms and keywords, including: "abdominal surgery" "postoperative pulmonary complications" "inspiratory muscle training" "physiotherapy" and "early mobilization". The search was restricted to English-language studies reporting clinical outcomes related to physiotherapy interventions in abdominal surgery patients.

Inclusion Criteria

Studies Were Selected Based On The Following Criteria:

Study Designs: Randomized controlled trials (RCTs), prospective or retrospective cohort studies, and systematic reviews with population includes patients undergoing abdominal surgery. Interventions done in the study were physiotherapy-based approaches, including inspiratory muscle training (IMT), breathing exercises, and early mobilization techniques. Outcomes used in the studies were postoperative pulmonary complications (PPCs), respiratory muscle strength, and respiratory functions. Secondary outcomes used in the studies were diaphragmatic excursion, length of hospital stay, and quality of life (QoL). A total of 10 studies out of 25 meeting the inclusion criteria were selected for data extraction. The details systematically recorded from each study were study design, sample size, type of intervention, and key outcomes measured used. The methodological quality of the included studies was assessed using PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Rothman et al., 2014) and GRADE criteria (Grading of Recommendations, Assessment, Development, and Evaluations) (Hanekom et al., 2012)

This structured approach ensured a rigorous evaluation of the evidence, allowing for a reliable synthesis of findings on the efficacy of physiotherapy interventions in improving postoperative outcomes for abdominal surgery patients.

RESULTS AND DISCUSSION

1. Respiratory Muscle Strength & Function

Impact Of Inspiratory Muscle Training (IMT):

Huang et al. (2022) demonstrated that preoperative IMT (≥50% maximal inspiratory pressure [MIP]) significantly reduced PPCs (0% vs. 15.8% in controls) and improved diaphragmatic excursion (37.5 mm vs. 25.3 mm, $p = 0.012$). Similarly, Mans et al. (2015) found IMT enhanced MIP by 30% and reduced atelectasis rates. However, Dronkers et al. (2008) noted no significant improvement in lung volumes, suggesting IMT primarily benefits muscle strength rather than lung capacity.

IMT: Huang et al. (2022) reported a 36.5% increase in maximal inspiratory pressure (MIP) (*p* = 0.004) and improved diaphragmatic excursion (*p* = 0.012). PEP vs. DBEs: Olsén et al. (2025) found PEP was preferred in 65% of cases, while DBEs were used in 14%.

Deep Abdominal Exercises: Kim & Lee (2013) demonstrated improved forced vital capacity (FVC) and lumbar stability (*p* < 0.05).

2. Breathing Exercises And Early Mobilization

Breathing Exercises: Silva et al. (2013) reported no additional benefit of deep breathing exercises over early mobilization alone in reducing PPCs. Conversely, Souza Possa et al. (2014) found that incentive spirometry and positive expiratory pressure (PEP) reduced atelectasis (0% vs. 15.8%) and shortened hospital stays (9.2 vs. 12.1 days, $p < 0.05$).

Early Mobilization: Browning et al. (2007) highlighted that early ambulation (<48 hours post-surgery) improved physical function and reduced complications. Hanekom et al. (2012) recommended mobilization as a first-line intervention in clinical algorithms.

3. Diaphragmatic Function

Ultrasound Findings: Huang et al. (2022) showed IMT preserved diaphragmatic excursion postoperatively (37.5 mm vs. 25.3 mm in controls, *p* = 0.012).

Hanekom et al. (2012): CPAP was recommended for persistent hypoxemia.

4. Incidence Of Postoperative Pulmonary Complications (PPCs)

Olsén et al. (2025): 76% of 1,492 patients performed breathing

exercises postoperatively, with a median initiation time of 3.63 hours. Early initiation (<3 hours) reduced PPCs, particularly in high-risk patients (OR > 2.04, *p* < 0.001).

Huang et al. (2022): IMT reduced PPCs by 79% (*p* < 0.001) in upper abdominal surgery patients compared to controls.

Hanekom et al. (2012): Expert consensus prioritized early mobilization and frequent breathing exercises (≥5 breaths/hour) to prevent PPCs.

5. Quality Of Life & Hospital Stay

IMT Group (Huang et al., 2022): Improved QoL in physical health domains (*p* = 0.045).

Olsén et al. (2025): No significant difference in hospital stay, but PPCs delayed recovery.

6. Clinical Guidelines And Delphi Consensus

Hanekom et al. (2012) developed a physiotherapy algorithm through Delphi consensus, emphasizing: Upright positioning and coughing techniques, frequent breathing exercises (≥5 maximal breaths/hour), and Early mobilization (walking 5 m on postoperative day 1).

The panel rated CPAP as effective for hypoxemia but cautioned against overreliance on incentive spirometry due to limited evidence.

Limitations of Current Evidence

Heterogeneity in Interventions and Outcome Measures

One of the key limitations across studies investigating inspiratory muscle training (IMT) and postoperative pulmonary complications (PPCs) is the significant variability in exercise protocols and outcome measures. For instance, studies differ widely in the intensity of IMT prescribed, with some using 30% of maximal inspiratory pressure (MIP) while others employ 60% or higher, making it difficult to compare outcomes directly. Additionally, the frequency and duration of training sessions vary considerably, ranging from daily 30-minute sessions to shorter, twice-weekly regimens. Outcome measures are also inconsistent, with some trials defining PPCs strictly as radiologically confirmed pneumonia or atelectasis, while others include broader clinical indicators such as oxygen desaturation or prolonged mechanical ventilation. This lack of standardization complicates meta-analyses and clinical guideline development.

Small sample sizes limit generalizability: Many studies in this field suffer from small sample sizes, which reduce statistical power and increase the risk of type II errors. For example, Huang et al. (2022) included only 28 participants in their IMT intervention group, which may not adequately represent the broader surgical population. Small cohorts are particularly problematic in subgroup analyses, such as assessing high-risk patients (e.g., those with COPD or obesity), where larger numbers are needed to detect meaningful differences. These limitations underscore the need for larger, multicenter randomized controlled trials (RCTs) to strengthen the evidence base.

Inconsistent definitions of postoperative pulmonary complications: Another major challenge is the lack of a universally accepted definition for PPCs, leading to variability in reported incidence rates. Rothman et al. (2014) highlighted this issue, demonstrating that studies using stricter criteria (e.g., radiographic confirmation plus clinical symptoms) report lower PPC rates than those relying solely on clinical judgment. This inconsistency complicates comparisons across trials and may obscure the true efficacy of interventions like IMT or early mobilization. Standardized definitions, such as those proposed by the European Perioperative Clinical Outcome (EPCO) consortium, should be adopted in future research to improve reproducibility and clinical applicability.

Lack of long-term follow-up data: Most existing studies focus on short-term outcomes, typically assessing PPCs only during the immediate postoperative period (e.g., 7–30 days). However, the long-term impact of respiratory interventions-such as whether preoperative IMT reduces chronic dyspnea or readmission rates-remains poorly understood. Few trials follow patients beyond hospital discharge, missing opportunities to evaluate sustained functional benefits or late complications. Longitudinal studies with follow-up periods of six months or longer are needed to determine whether these interventions confer lasting advantages in pulmonary function, quality of life, or healthcare utilization.

Key Findings

Preoperative inspiratory muscle training (IMT) enhances respiratory muscle strength, particularly the diaphragm, which is often impaired after surgery due to anesthesia, pain, or mechanical ventilation. Preoperative IMT strengthens inspiratory muscles, preserving diaphragmatic function post-surgery. Breathing exercises within 3 hours post-surgery reduce PPCs (Olsén et al., 2025).

Clinical Implications

IMT protocols should be implemented 2–4 weeks preoperatively (30 min/day, 50–60% maximal inspiratory pressure). Postoperative breathing exercises must begin early (<3 hours) to counteract diaphragm dysfunction. Preoperative IMT should be initiated ≥3 weeks before surgery at 50% MIP, progressing weekly. In postoperative care mobilization over breathing exercises will help to prevent post operative complications due to immobility. Multimodal approaches in combination of inspiratory muscle training, PEP, and early ambulation for optimal results (Souza Possa et al., 2014).

Future Research

The Need for Standardized Definitions and Protocols: A critical limitation in current research on postoperative pulmonary complications (PPCs) is the lack of standardized definitions and intervention protocols. Studies vary widely in how they define PPCs-some rely on clinical symptoms such as hypoxia or increased respiratory effort, while others require radiological confirmation of conditions like pneumonia or atelectasis. This inconsistency makes it difficult to compare findings across studies and draw definitive conclusions about the effectiveness of interventions such as inspiratory muscle training (IMT) or early mobilization. Similarly, intervention protocols-including IMT intensity, exercise frequency, and the timing of postoperative breathing exercises-differ significantly between trials. Without uniform criteria, it remain

CONCLUSION

Structured physiotherapy programs, particularly those incorporating IMT and early mobilization, significantly reduce PPCs and enhance recovery after abdominal surgery. Clinicians should adopt evidence-based algorithms to standardize care. Future research should address protocol heterogeneity and long-term efficacy. Breathing exercises, particularly IMT and PEP, reduce PPCs and improve respiratory outcomes after abdominal and cardiothoracic surgery. Early initiation and structured protocols are critical. Future research should standardize interventions and explore long-term effects.

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