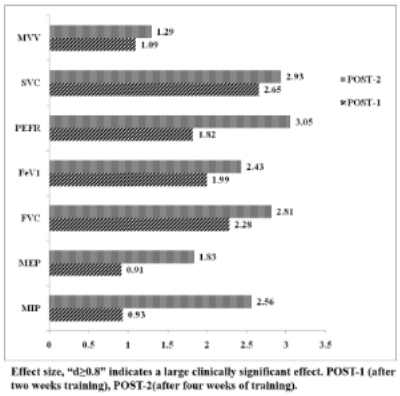
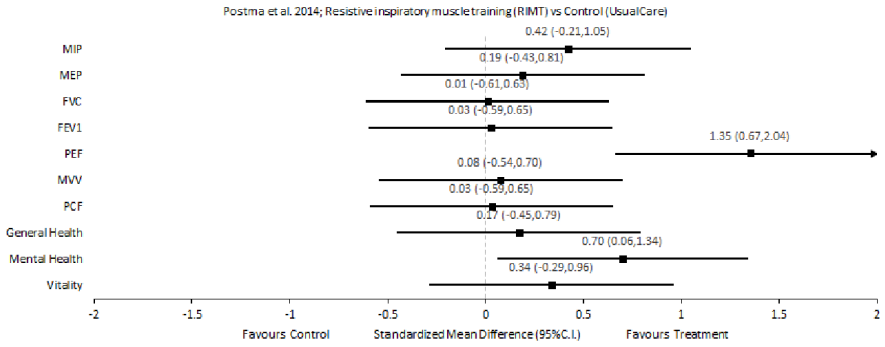
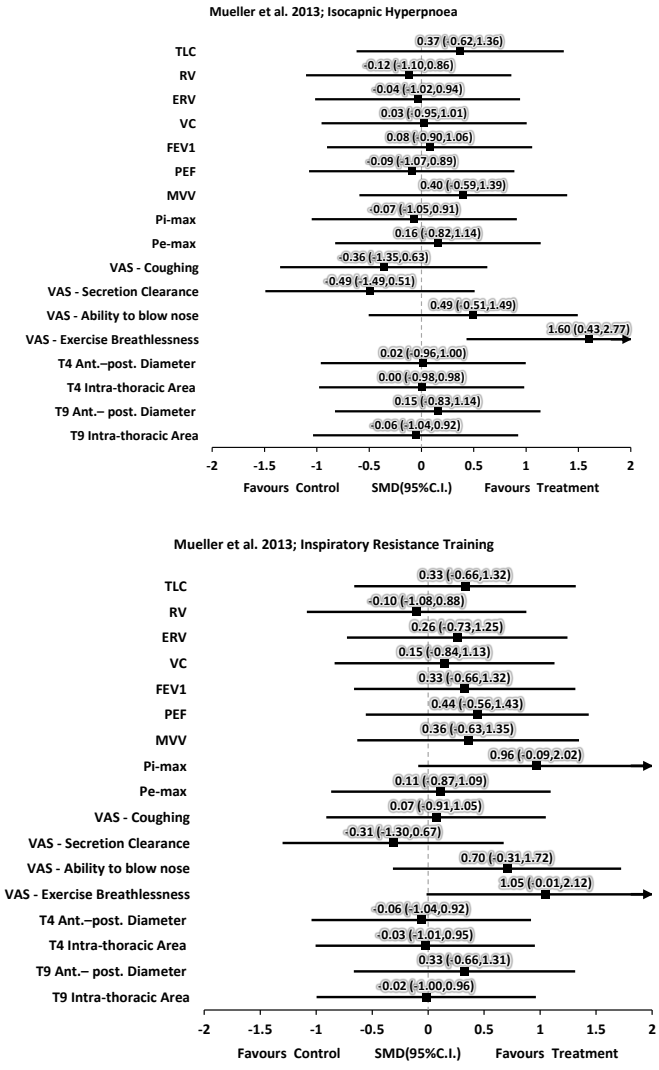
Author Year Country Research Design Score Sample Size	Methods	Outcome
Boswell-Ruys et al. 2020 Australia RCT PEDro = 10 Level 1b N = 62	**Population:** 62 patients with tetraplegia (C4-C8) with related respiratory deficits; 58 males and 4 females; mean age 53,6 years; level of injury C4 (n = 21), C5 (n = 12), C6 (n = 16) and C7 (n = 13); AIS A (n = 32), AIS B (n = 9), and AIS C (n = 21). **Treatment:** Participants were allocated to sham (n = 32) or active (n = 30) treatment. All participants performed supervised RMT with a single threshold RMT device (the sham device was modified to hold the pressure valve permanently open). 3 to 5 sets of 12 breaths (IMT and EMT, separated by quiet breathing for 2 min) were performed twice daily, 5 days a week for 6 weeks, increasing 10% weekly of each participant's baseline PImax and PEmax if tolerated. **Outcome Measures:** PImax, (IC), VC, FVC, FEV_1, peak expiratory flow while coughing (PEFc), TLC, PEmax at TLC, perceived breathlessness, respiratory-related morbidity, respiratory health (the St George Respiratory Questionnaire (SGRQ)) and quality of life (the Short Form Health Survey: walk/ wheel (SF-36ww) and the EuroQol-Five Dimensional Visual Analogue Scale (EQ-5D VAS)) were collected at baseline, 6 weeks and 1 year. **Chronicity:** Patients were included if they had acute (< 6 months since injury) or chronic SCI.	1. After 6 weeks of RMT PImax was significantly greater in the active group compared with the sham group; SGRQ score improved more in the active group compared with the sham group (mean between-group difference 10.3 points, 95% CI 0.01 to 20.65, p = 0.046); Borg scores for breathlessness during 10 inspiratory loaded breaths reduced more in the active group compared with the sham group (mean between-group difference 0.96, 95%CI 0.01 to 1.91, p = 0.049); and Borg scores at rest were greater in the sham group (mean between-group difference 0.64, 95% CI 0.11 to 1.17, p = 0.021). 2. After one year of unsupervised training, in comparison of baseline data, there was no significant difference between active and sham groups in any outcome measures

		except for the incidence of respiratory complications (there was a greater total number of respiratory complications in the sham group (n = 10) compared with the active group (n = 3), p = 0.017).
Sikka et al. 2021 India RCT PEDro = 4 Level 2 N = 96	**Population:** 96 patients within first week (mean time post injury 1.05 days) of traumatic cervical SCI; 72 males and 24 females; mean age 40.98 years; AIS A (n = 57) and AIS B (n = 49); and level of injury C4-C5 (n = 16), C5-C6 (n = 50), and C6-C7 (n = 30). **Treatment:** Patients were divided to: • Resistive IMT (RIMT) group (n = 48) received an IMT and EMT twice daily, 5 days per week, with 3 sets of 12 inspirations and then 3 sets of 12 expiration for four weeks with an IMT Threshold trainer. Training intensity began at 30% PImax and 30% PEmax; and was increased on alternate days by 10% (if tolerated) and was capped at 70% of the very best weekly MIP or MEP. Conventional intervention, including deep breathing exercises, huffing and cough assisting, postural drainage, percussion, vibration, and other rehabilitative programs like passive range of motion exercises, MAT exercise, sitting balance and upper limb	1. The pre-training and post-training mean values of all outcome measures revealed significant differences within groups (P < 0.05). 2. RIMT, compared to control group, resulted in a highly significant positive effect on all measures, recorded after 2 and 4 weeks of training (P < 0.01). 3. The effect size difference between RIMT and control group for all the outcome measures was large.

	functional training were administered. • Control group (n = 48) received only the conventional intervention. **Outcome Measures:** Pulmonary function testing / Spirometry (FVC, FEV_1, PEFR, SVC (slow vital capacity) and MVV (Minute ventilation volume)) and respiratory muscle strength (MIP and MEP) were obtained before intervention; and after two and four weeks of intervention. **Chronicity:** Patients were included within the first week after injury.	
	Comparison of Effect Sizes ("Cohen -d values") for pre to post training changes between RIMT and Control Group:  Effect size, "d≥0.8" indicates a large clinically significant effect. POST-1 (after two weeks training), POST-2(after four weeks of training). Figures are extracted from the original article (Sikka et al. 2021), which is licensed under Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.	
Postma et al. 2014 The Netherlands RCT PEDro = 7 Level 1b N = 40	**Population:** *Resistive inspiratory muscle training group (RIMT):* Mean age: 47.1 yr; Gender: male=20, female=1; *Control Group:* Mean age: 46.6 yr; Gender: male=15, female=4; Level of injury: T12 and above; Severity of injury: complete=24, incomplete=16. **Intervention:** Patients were randomly assigned to receive usual rehabilitation care plus RIMT with a threshold trainer (RIMT group), or usual rehabilitation care only (control group).	1. MIP improved more in the RIMT group compared with the control group 1 week after the intervention period (mean difference=11.67 cm H_2O, p=0.002); this difference was no longer significant 8 weeks after the intervention period (p=0.065) or at 1 yr after discharge from

	Outcome Measures: The following at baseline, after 8 weeks of intervention, 8 weeks after intervention, 1 yr after discharge from inpatient rehabilitation: maximum inspiratory pressure (MIP), maximum expiratory pressure (MEP), FVC, FEV_1, peak expiratory flow (PEF) rate, maximum ventilation volume, health-related quality of life (HRQoL), and 36-item short-form health survey (SF-36). **Chronicity:** Median number of days since injury was 74 (RIMT group) and 88 (control group).	inpatient rehabilitation (p=0.271). 2. No other between-group differences were found in any of the other measures of respiratory function. 3. The RIMT group improved more in mental health compared with the control group 1 week after the intervention period (p=0.006).
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data. 	
Mueller et al. 2012 & 2013 Switzerland RCT PEDro = 5 Level 2 N = 24	**Population:** N=24 participants with traumatic complete tetraplegia (C5-C8, AIS A) were randomly assigned to 1 of 3 groups. *Placebo group*: 6M 2F; mean (SD) age: 41.6(17.0) yrs; DOI: 6.6(1.4) months. *Isocapnic hyperpnea (IH) group*: 6M 2F; mean (SD) age: 33.5(11.7) yrs; DOI: 6.6(0.9) months. *Inspiratory resistive training (IRT) group:* 6M 2F; mean (SD) age: 35.2(12.7) yrs; DOI: 6.0(0.0) months. **Treatment:** All participants completed 32 supervised training sessions over 8 weeks.	1. Compared to placebo training, IRT showed high effect sizes for inspiratory muscle strength (d=1.19), VAS values of “cleaning the nose” (d=0.99), and the physical component of subjective quality of life (d=0.84). 2. IH compared with placebo showed a high effect size for breathlessness

	Outcome Measures: inspiratory and expiratory muscle strength. **Chronicity:** 6.6 (± 0.9) months since injury.	during exercise (d=0.81). 3. Friedman analysis showed a significant effect for IRT vs. placebo and vs. IH on inspiratory muscle strength.
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention (IH and IRT respectively) data. 	

Van Houtte et al. 2008 Belgium RCT PEDro = 8 Level 1b N = 14	**Population:** C4-T11 AIS A, B, or C; 2-6 months since injury. **Treatment:** sham or normocapnic hyperpnea training for 15-30 min x 8 wks; average of 27 sham and 28 training sessions. **Outcome Measures:** MIP, VC, MVV, respiratory muscle endurance, respiratory infections. **Chronicity:** Time since injury ranged from 2 to 6 months since injury.	1. Significant increase in MIP, VC, MVV, and respiratory muscle endurance. and lung volumes after IMT. 2. Number of respiratory infections was less in the training than the sham group (1 vs. 14).
Roth et al. 2010 USA RCT PEDro = 4 Level 2 N = 29	**Population:** *Resistance Training Group*: Mean age: 31.1 yr; Gender: male=81%, female=19%; *Sham Training Group:* Mean age: 28.9 yr; Gender: male=69%, female=31%; Level of injury: C4-C7, T1; Severity of injury: complete. **Intervention:** Patients were randomly assigned to either expiratory muscle resistance training or sham training for a total of 6 weeks. **Outcome Measures:** The following before and after the training program: FVC, FEV_1, maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), IC, expiratory reserve volume (ERV), total lung capacity (TLC), functional residual capacity (FRC), and residual volume (RV). **Chronicity:** Patients were invited to participate in the study if the SCI was recent and had occurred within 6 months' time. No further information regarding time since injury was provided.	1. Multivariate analysis did not reveal any significant differences between the resistance training and sham training groups for any of the pulmonary function tests ($p=0.22$). 2. Univariate analysis revealed significant improvements in FVC ($p=0.02$), FEV_1 ($p=0.02$), ERV ($p=0.04$), MIP ($p=0.002$), and MEP ($p<0.001$) in the resistance training group. 3. Univariate analysis revealed significant improvements in FVC ($p=0.04$), FEV_1 ($p=0.01$) and ERV ($p<0.01$) in the sham training group.

Liaw et al. 2000 Taiwan RCT PEDro = 4 Level 2 N = 30	**Population:** N=30 participants with SCI (C4-C7, 30-134 post-injury); 20 participants completed (13 control,17 IMT group), 8M:2F in each group, mean (SD) age RIMT:30.9(11.6) yrs; control: 36.5(11.5) yrs. **Treatment:** Target resistive IMT or control; 15-20min 2x/day × 6wks; other rehab activities continued. **Outcome Measures:** Spirometry, MIP. **Chronicity:** Mean time since injury (53.1) days.	1. Pre-post % change of VC and TLC in IMT group was greater compared to change in control values. 2. MIP improved in both groups which might be due to natural progression of improvement from SCI, learning to do the maneuver, and/or insufficient length of training.
Derrickson et al. 1992 USA RCT PEDro = 3 Level 2 N = 11	**Population:** Age range: 16-41 yr; Gender: male=6, female=5; Level of injury: C4-5 to C7; Severity of injury: complete. **Intervention:** Patients were randomly assigned to receive resistive inspiratory muscle training (RIMT) or abdominal weights (AbWts) training for 7 weeks. Training sessions consisted of two 15-minute treatments each day, 5 days a week. **Outcome Measures:** The following after one week and seven weeks: FVC, IC, maximal voluntary ventilation (MVV), PEF rate, and increased inspiratory mouth pressure (PImax). **Chronicity:** Time since injury was an average of 12 days (RIMT group) and 25 days (AbWts group).	Between group comparison: 1. There were no significant differences in FVC, MVV, PEFR, PImax, and IC between patients who received RIMT training and those who received AbWts training ($p>0.05$ in all cases). Within group comparison: 2. After 7 weeks, patients who received RIMT training experienced a significantly larger FVC ($p<0.001$), a larger MVV ($p<0.05$), a higher PEF ($p<0.01$), a lower PImax ($p<0.001$), and a higher IC ($p<0.05$) compared to these measures after 1 week. 3. After 7 weeks, patients who received AbWts

		training experienced a significantly larger FVC ($p<0.001$), a larger MVV ($p<0.001$), a higher PEF ($p<0.001$), and a lower PImax ($p<0.001$) compared to these measures after 1 week.
Raab et al. 2019 Switzerland Case control Level 3 N = 67	**Population:** 67 patients with traumatic (n = 59) or non-traumatic (n = 8) SCI; motor lesion level from C4 to T12; 55 males and 12 females; mean age 50 (35 to 66) years; mean time post injury 1.9 (1.2-2.9) months; AIS A/B (n = 41) and AIS C/D (n = 26). **Treatment:** IMT with a training device for isolated inspiratory resistance with the valve calibrated and adjusted (9–41 cmH_2O) according to the participant's PImax. IMT started about 6 weeks after injury and lasted for a period of about 6 consecutive weeks with 3–5 training sessions per week and with up to 90 repetitions per training session (according to the individual capacity, and individually and gradually increased). All participants received standard physiotherapy as part of the comprehensive in-patient rehabilitation program. **Outcome Measures:** Respiratory muscle strength (PImax and PEmax), repetitions per session, number of training sessions, and training intensity (% resistance of the individual baseline value of PImax). **Chronicity:** Mean time post injury 1.9 (1.2 – 2.9) months.	1. Effect size of 7% (95% confidence interval (CI) 2.8–11.6%) increase in PImax per 10 units (cmH_2O) of increase in training intensity. The association of PImax with training intensity was independent of AIS (test of interaction: $chi^2 = 0.18$, d.f. = 1, p = 0.67) and lesion level ($chi^2 = 0.00$, d.f. = 1, p = 0.99). 2. The effect of training intensity on PEmax was conditional on AIS (test of interaction: $p < 0.021$). While participants with motor complete lesions (AIS A/B) showed a 6.8% (95% CI 2.1 to 11.7%) increase in PEmax per 10 units (cmH_2O) of increase in training intensity, the corresponding adjusted effect size in the group with motor incomplete lesions (AIS C/D) was 0.1% (95% CI −4.3 to 4.5%).

Shin et al. 2019 Republic of Korea Case control Level 3 N = 104	**Population:** 104 patients with acute (n = 14), subacute (n = 42), and chronic (n = 48) SCI; 78 males and 26 females; mean (SD) age 48.7 (± 17.5) years; AIS A (n = 21), AIS B (n = 7), AIS C (n = 30) and AIS D (n = 46); injury severity (complete, n = 21 and incomplete, n = 83); level of injury (tetraplegia, n = 65, paraplegia, n = 39); and mean (SD) disease duration 97.4 (± 139.2) days. **Treatment:** Self-directed RMT and care for 4 weeks (more than 5 days a week) consisting in glossopharyngeal breathing exercises, IMT using incentive spirometry, and air stacking exercises with a resuscitation bag. Patients were subgrouped by injury severity, level of injury and disease duration for analysis. **Outcome Measures:** Pulmonary function evaluation (FVC in sitting position (ΔFVCsit), FVC in supine (ΔFVCsup), and PCF (ΔPCF)) before and after the short-term rehabilitation therapy. **Chronicity:** Time since injury not specified. Patients were included if they had an acute, subacute, or chronic SCI.	1. FVCsup, FVCsit, and PCF were more severely affected in the tetraplegic group compared to the paraplegic group (P < 0.01) at baseline. 2. The absolute value of FVCsup was significantly higher compared with that of FVCsit at the initial and final assessment in all subgroups, except for the acute group. 3. After treatment protocol, the absolute values of FVCsup, FVCsit, and PCF had significantly improved in all subgroups regardless of the injury level and severity, as well as disease duration. 4. The subacute group showed the highest improvement in ΔFVCsit and ΔPCF, compared with the acute and chronic groups (P < 0.05); and a greater ΔFVCsup compared with the chronic group (P = 0.002) and a higher tendency compared with the acute group (P = 0.056).

McDonald & Stiller 2019 Australia Pre–post Level 4 N = 7	**Population:** 7 male patients with acute complete (AIS A) SCI, mean age 33.6 (22-62) years; level of injury C4 (n = 1), C6 (n = 3), C7-T1 (n = 1), T4 (n = 1), and T6 (n = 1); and time since injury 10.1 (5-17) days. **Treatment:** IMT protocol consisting in a high-resistance, low-repetition, using a hand-held electronic IMT device. Each session comprised 3-6 sets of 6 breaths, with rest allowed between sets as desired and a total session time less than 10 minutes. Training load was set at 50% of PImax (RPE of 6-8) and once the participant's RPE was < 6 and/or they were able to complete the entire IMT session, training pressure was increased by 10% per week to a maximum of 90% PImax. Training frequency was once per day for 4–5 days/week, with 2–3 rest days/week. IMT sessions continued for the duration of each participant's stay at the hospital to an arbitrary maximum of four weeks. **Outcome Measures:** Feasibility (number of sessions when the criteria to participate in IMT were met/not met, and reasons why), safety, and efficacy (PImax, FVC and PEF rate) were collected before, during and after intervention. **Chronicity:** Time since injury was 10.1 (5 – 17) days.	1. A mean (range) of 7.1 (3–11) IMT sessions per participant delivered over 10.7 (4–17) days were performed. The variability in the number of IMT sessions and days over which it was delivered resulted from the variability in participants' hospital LOS. 2. No adverse safety outcomes were identified. 3. Lung function parameters were variable both between and within participants (improvements in lung function were seen for 4 of the 7 participants over the duration of their IMT sessions).
Raab et al. 2018 Switzerland Case control Level 3 N = 79	**Population:** *Inspiratory Muscle Training Group – AIS A/B:* Mean age: 48 yr; Gender: male=10, female=5; Level of injury: N/R; Injury severity: tetraplegia=7, paraplegia=8. *Inspiratory Muscle Training Group – AIS C/D:* Mean age: 63 yr; Gender: male=22, female=5; Level of injury: N/R;	1. PImax was seen to significantly increase for those treated with combined muscle training, regardless of AIS score ($p<0.001$) and for those treated with inspiratory

	Injury severity: tetraplegia=22, paraplegia=5. *Combined In- and Expiratory Muscle Training Group – AIS A/B:* Mean age: 44.5 yr; Gender: male=14, female=2; Level of injury: N/R; Injury severity: tetraplegia=7, paraplegia=9. *Combined In- and Expiratory Muscle Training Group – AIS C/D:* Mean age: 60 yr; Gender: male=18, female=3; Level of injury: N/R; Injury severity: tetraplegia=18, paraplegia=3. **Intervention:** Participants had up to 5 training sessions per week of either inspiratory muscle training or combined in- and expiratory muscle training. **Outcome Measures:** PImax, PEmax, FVC, forced expiratory volume, sniff nasal inspiratory pressure, and PEF. Results were stratified by AIS groups A/B and C/D. **Chronicity:** On average patients were 2.4 months post injury.	muscle training only (p=0.008). 2. PEmax was seen to significantly increase for those treated with combined muscle training, regardless of AIS score (p<0.001) and for those with AIS scores of C or D treated with inspiratory only muscle training (p<0.001). 3. FVC was seen to significantly increase in those who were treated with combined muscle training, regardless of AIS score (p<0.001). The same trends were observed for those in the inspiratory only muscle training groups (p<0.05). 4. Forced expiratory volume was found to significantly increase in participants treated with combined muscle training, regardless of AIS score (p<0.05), while the same trend was observed for those treated with inspiratory only muscle training (p<0.05). 5. Sniff nasal inspiratory pressure was found to significantly increase in those treated with combined muscle

		training ($p<0.001$), regardless of AIS score. No significant improvements were observed in the inspiratory only muscle training group. 6. PEF was only seen to improve significantly in the AIS C and D groups regardless of type of intervention ($p<0.05$), but not the AIS A/B groups.
Berney et al. 2002 Australia Case control Level 3 N = 14	**Population:** Mean age: 28 yr; Gender: male=11, female=3; Level of injury: C5-C7; Severity of injury: complete. **Intervention:** Patients who received a tracheostomy were compared to patients who were extubated and received physiotherapy. **Outcome Measures:** The following at the time of extubation/the day of tracheostomy: FVC, PaO_2/FiO_2, total number of physiotherapy treatments, number of physiotherapy treatments in ICU, LOS in ICU, days requiring MV, LOS in acute ward after discharge from ICU, days from injury to fixation. **Chronicity:** Patients were studied beginning within 24 hr of injury.	1. There was no significant difference in FVC between tracheostomized patients and physiotherapy patients ($p>0.05$). 2. There was no significant difference in PaO_2/FiO_2 ratios between tracheostomized patients and physiotherapy patients ($p>0.05$). 3. There was no significant difference in total number of physiotherapy treatments between tracheostomized patients and extubated patients. Patients who were extubated and received physiotherapy required significantly fewer treatments compared to tracheostomized

		patients in ICU (p=0.047). 4. Tracheostomized patients spent significantly more days in ICU than physiotherapy patients (p=0.006) and required MV significantly longer than the physiotherapy group (p=0.018). 5. There was no significant difference in the LOS in the acute ward between groups (p>0.05). 6. There was no significant difference in the time from injury to fixation between groups (p>0.05).