Author Year Country Research Design Score Sample Size	Methods	Outcome
Boswell-Ruys et al. 2020 Australia RCT PEDro = 10 Level 1 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 PI_{max} and PE_{max} if tolerated. **Outcome Measures:** PI_{max}, (IC), VC, FVC, FEV_1, peak expiratory flow while coughing (PEFcough), TLC, PE_{max} at TLC, perceived breathlessness, respiratory-related morbidity, respiratory health (the St. George Respiratory Questionnaire [SGRQ]) and quality of live (the Short Form Health Survey: walk/ wheel (SF-36ww) and the EuroQol-Five Dimensional Visual Analogue Scale) were collected at baseline, 6 weeks and 1 year.	1. After 6 weeks of RMT PI_{max} 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 1 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).

Soumyashree & Kaur 2020 India RCT PEDro = 7 Level 1 N = 27	**Population:** 27 participants with paraplegia; 22 males and 5 females; mean age 31.7 years; AIS A (n = 23) and AIS B (n = 4); level of injury T1-T12 (n = 7), T5-T7 (n = 6); and T8-T12 (n = 14); and mean time since injury 9.35 months. **Treatment:** Patients were divided in two groups, they performed 5 session a week during 4 weeks: ● IMT group (n = 15) trained used an Inspiratory Muscle Trainer with a resistance adjusted at 40% of the obtained MIP. The resistance was increased to the next level as the participants completed 50 breathes without difficulty for consecutive 3 days. Participants repeated this maneuver for 15 min with 2–3 min rest periods in between, 5 days per week for 4 weeks. ● Control group (n = 12) instructed to inspire maximally, predominantly with abdominal motion, while reducing upper ribcage motion. This cycle was repeated 60 times per session twice a day for 20 days. Intervention was given for 15 min. **Outcome Measures:** 12-minute wheel chair aerobic test (12-MWAT), multistage fitness test (MSFT), six minutes push test (6-MPT), MIP, MEP and Modified Borg dyspnea scale (MBS) were collected pre and post intervention.	1. Between group analysis showed that IMT group scored significantly better than control group on 12 MWAT (95% CI, 3.9 to 9.2), MSFT (95% CI, 1.0 to 3.3), 6-MPT (95% CI, 15.9 to 44.4), MIP (95% CI, −30.2 to −12.1), MEP (95% CI, 8.6 to 25.7) and on MBS score (95% CI, −3.2 to −0.6). 2. Within group analysis of IMT group showed significant improvements in MIP (P = 0.001) and MEP (P = 0.001), in MBS scores (P = 0.001), in VO_2max scores (P = 0.001) of 12 MWAT, in MSFT (P = 0.001), and in 6-MPT scores (P = 0.001) when compared with the baseline values. 3. Within group analysis of control group showed significant improvements on most of the outcomes variables after training.
Zhang et al. 2021 China RCT PEDro = 5	**Population:** 18 patients with SCI; 15 males and 3 females; mean age 32.5 years; mean time since injury 1.005 years; ASIA B (n = 13) and ASIA C (n = 5).	1. A significant increase was observed in the intervention group for FEV_1 from baseline to mid-

Level 2 N = 18	**Treatment:** Patients were assigned to one of two groups. ● Music therapy group (n = 9) that performed oral motor respiratory exercise (OMREX) and vocal intonation therapy (VIT) (OMREX + VIT). ● Control group (n = 9) received routine respiratory function training. Therapy session of the two groups were both 30 min per day, 5 times a week, for a total of 12 consecutive weeks. **Outcome Measures:** Respiratory function tests (TLC, IC, residual capacity, FEV_1, FVC, maximal mid-expiratory flow rate (MMF), FEV_1/FVC, maximal inspiratory and expiratory flow volume loops), vocal assessment (sound pressure level (SPL) and voice quality), and questionnaires (SGRQ) and QoL) were collected at baseline (t_0), at 6 weeks (t_1) and after 12 weeks (t_2).	term (t_1 = 0.83 ± 0.08 L, F = 18.61, P = 0.0001). 2. Compared with the control group, the IC (t_2 = 1.93 ± 0.57 L, F = 5.565, P = 0.0224), FEV_1 (t_2 = 0.92 ± 0.06 L, F = 9.988, P = 0.0027), FVC (t_2 = 2.32 ± 0.81 L, F = 8.813, P = 0.0047), and MMF (t_2 = 2.59 ± 0.27 L/s, F = 4.951, P = 0.0111) were increased, and the FEV_1/FVC (t_2 = 39.66 ± 8.51%, F = 15.96, P = 0.0002) was decreased in the intervention group at 12 weeks. 3. The SGRQ (t_2 = 50.91 ± 11.26, F = 6.345, P = 0.0170) and QoL (t_2 = 71.43 ± 13.53, F = 4.734, P = 0.0371) values in the intervention group were significantly lower (better) than those in control group at 12 weeks.
Kim et al. 2017b Korea RCT PEDro = 6 Level 1 N = 37	**Population:** 37 participants with SCI receiving inpatient treatment; 22 males and 15 females; mean age 40.5 years; time since injury 14.01 years; and level of injury C4-C5 (n = 6), C6-C7 (n = 7), T1-T2 (n = 6), T3-T4 (n = 10), and T5-T6 (n = 8). **Treatment:** Participants were divided in three groups: ● Control group, n = 12. ● RMT group, n = 12. ● Integrated training group (ITG) (RMT with additional abdominal drawing-in maneuver), n = 13. The participants received the RMT routine therapy for one hour, 3 times a week for 8 weeks.	1. A comparison of the FVC and FEV1 prior to and following intervention showed a significant increase in the ITG and RMT group (P < 0.01). 2. Following intervention, FVC of the ITG and RMT group increased by an average of 19.98% and 10.41%, respectively, in comparison with the control group (increased by an average of only 1.78%) (p < 0.01). In addition, FEV_1 of the ITG and RMT group rose by an average of 16.71% and 9.80%, respectively, while that of the control group

	Outcome Measures: Spirometry (FVC and FEV_1) were collected before and after the intervention.	increased by an average of only 2.41% ($p < 0.01$). 3. Following the intervention, the FVC and FEV_1 of the ITG were increased further by an average of 9.75% and 7.01%, compared with those of the RMT group ($p < 0.01$).
Chen et al. 2016 China RCT PEDro = 4 Level 2 N = 98	**Population:** 98 males with traumatic SCI paraplegia; C5-C7; mean (SD) age 62.7 (± 10.8) years; mean (SD) time since injury 41.6 (± 10.8) years; and injury level T1-T2 (n = 39), T3-T4 (n = 32), and T5-T6 (n = 32). **Intervention:** Participants were divided in two groups: ● Experimental group (n = 49) acquired pulmonary rehabilitation exercise for 12 months, consisting in breath training and strength training. Pulmonary rehabilitation exercises contained breath training (lip breathing and abdominal breathing, each training for 20 min and three times a day). ● Control group (n = 49). All patients acquired conventional rehabilitation, including psychological rehabilitation and dietary guidance. **Outcome measures:** Pulmonary function (FEV_1, FVC, MVV) and FEV_1/FVC) and QOL (SF-36) were detected at baseline; during pulmonary rehabilitation at 2 months, 4 months, and 12 months; and after pulmonary rehabilitation 1 month.	1. The data analyses for 2 months, 4 months and 12 months displayed highly significant differences in pulmonary function and life-quality ($P < 0.01$) between experimental group and control group, the indicators of experimental group were higher than control group; but there was no difference ($P > 0.05$) after pulmonary rehabilitation 1 month between experimental group and control group.

Kader 2018 Egypt Prospective controlled trial Level 2 N = 36	**Population:** 32 patients with complete SCI, 23 males and 9 females, mean (SD) age 30.51 (± 6.82) years. **Treatment:** Patients were divided in two groups: ● Group A (n = 16) performed RMT using an inspiratory muscle trainer with a threshold positive expiratory pressure device. The patient performed 6 work sets, 5 min in duration, with a rest period in between for 3 min. All patients performed a 45 min training/day, five days/week for six weeks. The training intensity was initiated with 20% of each participant PI_{max} and PE_{max} and progressively increased as tolerated up to 40% of PI_{max} and PE_{max} at the end of the training program. ● Group B (n = 16): Control group. **Outcome Measures:** Arterial blood gases (PaO_2, $PaCO_2$ and pH), pulmonary function (FVC and FEV_1), heart rate (HR) and respiratory rate (RR).	1. The mean value of HR, RR, $PaCO_2$ and PH revealed significant reduction, where FVC, FEV_1 and PaO_2 revealed significant increase in group A at the end of the study. However, changes in group B were not significant. 2. There were significant differences between both groups at the end of the study in all the outcome measures ($P < 0.05$).
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 his valve calibrated and adjusted (9–41 cmH_2O) according to the participant's PI_{max}. IMT started about 6 weeks after injury and lasted for a period of about 6	1. Effect size of 7% (95% confidence interval (CI) 2.8–11.6%) increase in PI_{max} per 10 units (cmH_2O) of increase in training intensity. The association of PI_{max} 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 PE_{max} was conditional on AIS (test of

	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 (PI_{max} and PE_{max}), repetitions per session, number of training sessions, and training intensity (% resistance of the individual baseline value of PI_{max}).	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 PE_{max} 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 GPB 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.	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).
Gee et al. 2019 Canada Pre – Post Level 4 N = 6	**Population:** 6 wheelchair rugby athletes with SCI; 5 males and one female; age 33 ± 5 years; time since injury 157 ± 63 months. **Treatment:** Participants performed RMT consisting in two series of 30 repetitions, on 5 days of the week for 6 weeks. Initial inspiratory and expiratory pressure thresholds were set at 60% MIP and MEP determined at baseline. Resistance was increased once the participant could comfortably complete all 30 breaths and the associated dyspnea for each session that week was less than 6/10 on the Modified Borg Dyspnea Scale. **Outcome Measures:** Resting pulmonary function (MIP, MEP, IC, VC, expiratory and inspiratory reserve volume, FVC, FEV_1, PEF, TLC, and RV); resting cardiac function (left-ventricular end-diastolic volume, left ventricular end-systolic volume, left-ventricular stroke volume, ejection fraction, early and late diastolic filling velocities, ratio of early to late diastolic filling, mitral annular velocities during systole, early and late diastole, and BP [blood pressure]); exercise capacity (during maximal and submaximal tests); exercising lung volumes; field-based exercise performance (20 × 20 m repeated sprint field test); and adherence, dyspnea and intensity during the exercise sessions were assessed at pre-RMT, post-RMT and after a 6-week no RMT period.	1. Pulmonary function: a. From pre- to post-RMT both MIP (40%, p = 0.002) and MEP (25%, p = 0.007) increased without an increase from pre- to follow up assessment. b. PEF increased by 9% from pre- to post-RMT and remained elevated at follow-up (6.74 ± 1.51 *vs.* 7.32 ± 1.60 *vs.* 7.29 ± 1.85 L s^{-1}, both $P < 0.04$ vs. pre-RMT). c. Resting lung volumes and capacities were unchanged from pre-RMT at post-RMT and follow-up, except that FRC was significantly lower at follow-up compared to pre-RMT (3.70 ± 1.29 *vs.* 3.23 ± 0.99 l, $P = 0.021$). 2. Exercise capacity: a. Peak work rate was higher post-RMT (68 ± 22 W) than both pre-RMT (60 ± 23 W, P = 0.003) and at follow-up (63 ± 23 W, $P = 0.037$). b. VO_2peak increased in all athletes after RMT (1.24 ± 0.40 *vs.* 1.40 ± 0.50 l min^{-1}, $P = 0.12$) and was significantly lower at follow-up compared to post-RMT (1.40 ± 0.50 *vs.* 1.18 ± 45 l min^{-1}, $P = 0.041$).

		c. There were non-significant differences in peak V_E, average expiratory flow rate, oxygen pulse, work rate at the first or second ventilatory threshold, peak RER, V_T, fb, or peak HR between any time-points.
Leathem et al. 2021 USA Case series Level 4 N = 6	**Population:** 6 participants with SCI; 5 males and 1 female; incomplete injury (n = 4) and complete injury (n = 2); cervical injury (n = 4) and thoracic injury (n = 2); mean (SD) age 33 (± 18.6) years; and mean (SD) time since injury 7 (± 4) years. **Treatment:** Treatment consisted in two modalities over 8 weeks: ● Spinal Mobility X class: Each four-hour class (once per week) was comprised of three circuits: strengthening, aerobic training, and spinal mobility. ● IMT at home: Participants were trained in the use of a IMT device which provides consistent pressure for inspiratory muscle strength and endurance training, regardless of speed of breath. The training goal was to achieve 30 breaths, over 2 sessions a day, 5 days a week, over the training period, while resistance was progressed weekly. **Outcome Measures:** Subjective survey, transfer test, t-shirt test, four directional reach test, and four-directional trunk test were collected before and after the program.	1. None of the participants reported adverse effects due to the respiratory training; and they reported various improvements in the surveys. 2. Mean difference for all measures across participants indicates overall improvement in all four functional outcome measures.

Legg Ditterline et al. 2018 USA Pre – post Level 4 N = 44	**Population:** 44 participants with chronic SCI; 35 males and 9 females; mean age 39.5 years; level of injury C2 (n = 3), C3 (n = 4), C4 (n = 13), C6 (n = 3), T1 (n = 1), T2 (n = 3), T4 (n = 3), T6 (n = 4), T9 (n = 2), and T11 (n = 3); AIS A (n = 17), AIS B (n = 10), AIS C (n = 12) and AIS D (n = 5); and mean time since injury 102 months. **Treatment:** Participants were divided in: ● RMT Group (n = 24): Consisted in 20 sessions (for 4 weeks) of 45-minute training using a threshold positive expiratory pressure device and inspiratory muscle trainer assembled together using a 3-way valve system. Training load was increased regularly so participants were training at 60% of their PI_{max} and PE_{max} by the last week. ● Control group (n = 20). **Outcome Measures:** FVC, FEV_1, and beat-to-beat arterial blood pressure, heart rate changes during the 5-second-long maximum expiratory pressure maneuver (5s MEP) and the sit-up orthostatic stress test were collected before and after the intervention program.	1. Pulmonary function outcomes increased significantly in the RMT group compared with controls (FVC increased from 76% ± 13% to 82% ± 13% ($P < 0.01$), and FEV_1 increased from 68% ± 15% to 76% ± 15% ($P < 0.01$)). 2. Baroreflex sensitivity increases significantly in the trained group in response to maximal, acute expiratory effort that were not seen in the control group.
Shanmuga Priva & Kalpana 2018 India Pre – post Level 4 N = 20	**Population:** 20 males with chronic traumatic SCI (C5-T12). **Treatment:** Participants were divided in two groups: ● Group I, n = 10, received convectional chest physiotherapy including diaphragmatic breathing exercise, air shift maneuver, assisted coughing and active cycle of breathing technique.	1. There was a statistically significant improvement in Group II vs. group I in PI_{max}, PE_{max} and PEFR.

	• Group II, n = 10, received both IMT and the conventional chest physiotherapy. IMT was performed 2 sessions of 15 min per day, 4 days per week, for a period of 8 weeks; load was set at 30% of PI_{max}. **Outcome Measures:** RPE, PI_{max}, PE_{max}, and PEFR.	
Zhang et al. 2016 USA Pre – post Level 4 N = 6	**Population:** 6 males with cervical (C4-C7) SCI; mean (SD) age 48 (± 7.1) years; mean (SD) time since injury 16 (± 8.5) years; AIS A (n = 4) and AIS B (n = 2); level of injury C4 (n = 1), C5 (n = 2), C6 (n = 2) and C6-C7 (n = 1). **Treatment:** Participants underwent 10 min of functional magnetic stimulation (FMS) conditioning of the inspiratory muscles and 10 min FMS conditioning of the expiratory muscles (with 10-min break between); twice per day; 5 days per week, for 6 weeks. **Outcome Measures:** PI_{max} at RV, PE_{max} at TLC, IRV, ERV, PIF at RV, PEF at TLC, and compound muscle action potential of first and ninth lower intercostal muscles were collected before, during, and after the FMS protocol, and at a 4-week postconditioning period.	1. The CMAP amplitudes increased only as the magnetic stimulation intensity increased from 40% to 80% of maximal intensity of the magnetic stimulator. 2. No medical complications, pain or adverse effects were noted during the study period, except for one patient who reported paresthesias in his right upper arm (with a history of paresthesias). 3. Continuous improvements in inspiratory and expiratory functions were observed after 2, 4 and 6 weeks of conditioning, compared from baseline. 4. 4 weeks after conditioning MIP, IRV, PIF, MEP, ERV, and PEF decreased a 4.3%, 6%, 5.4%, 1.0%, 4.0%, and 8.1% respectively, from their values at the end of the 6-week conditioning protocol. Still, there were significant improvements in MIP ($p = 0.040$), PIF ($p = 0.0057$), MEP (0.035), PEF (0.003), and ERV ($p = 0.035$)), when compared with the baseline.

<table>
<tr>
<td rowspan="2">Postma et al. 2014;
Netherlands
RCT
PEDro = 7
Level 1
N = 40</td>
<td>Population: 40 participants with SCI (35M, 5F)
Mean (SD) age: 46.8 (14.3) years
Median (IQR) DOI: 74 (57-109) days for resistive IMT group & 88 (59-121) days for control group
30 tetraplegia, 10 paraplegia
24 motor complete SCI.
Treatment: Resistive IMT group (19): 8 weeks using IMT trainer + usual care; Control group (21): Usual care.
Outcome Measures: FVC, FEV_1, PEFR MVV, MIP, MEP, visual analogue scale for subjective breathing, and Short-Form-36.</td>
<td>1. Significantly greater increase in MIP in resistive IMT group (56.4±29.5 to 82.7±29.7cmH2O; mean±SD) than control group (56.1±23.5 to 70.7±28.1cmH2O) 1 week after intervention period, but loss of significance at 8 weeks and 1 year follow-ups.
2. MIP improved over longer period for those who continued resistive IMT post-intervention, compared to those who discontinued.
3. No significant between-group difference in changes of any other pulmonary outcome measure.</td>
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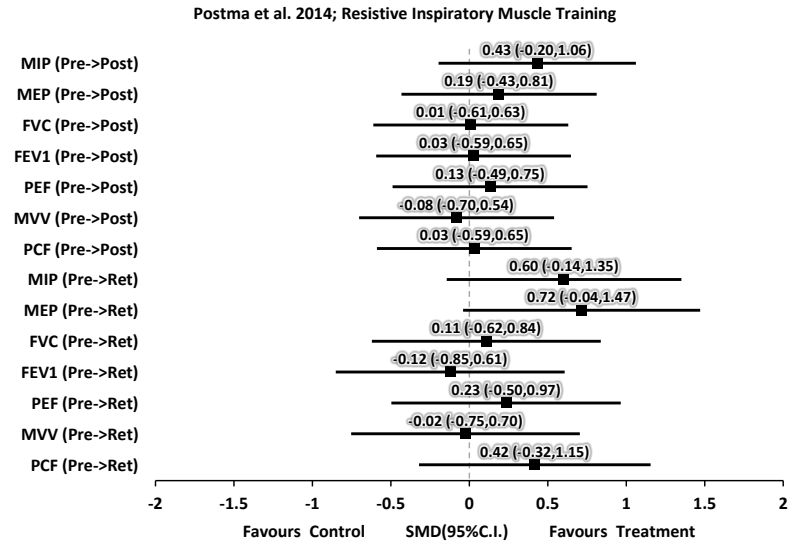
<tr>
<td colspan="2">Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data
 
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<tr>
<td>West et al. 2014
UK
RCT
PEDro = 4</td>
<td>Population: 10 athletes with cervical SCI (9M, 1F)
Mean (SD) age: 29.2 (2.7) years
Mean (SD) DOI: 9 (2.2) years
7 AIS-A, 3 AIS-B.</td>
<td>1. Increase in diaphragm thickness (+22% IMT vs. -3% placebo) and MIP (+11% vs. -6%) is significant between-groups</td>
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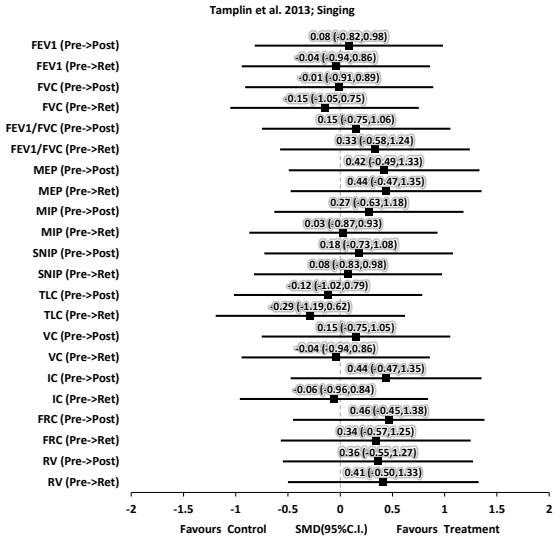
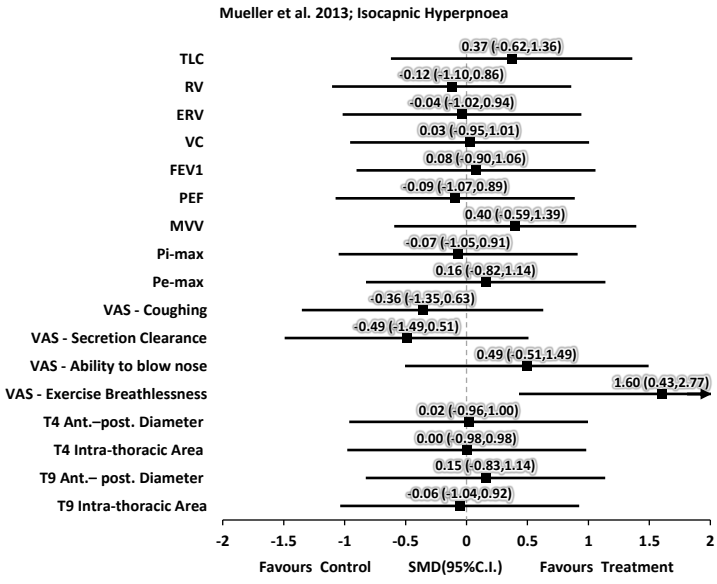
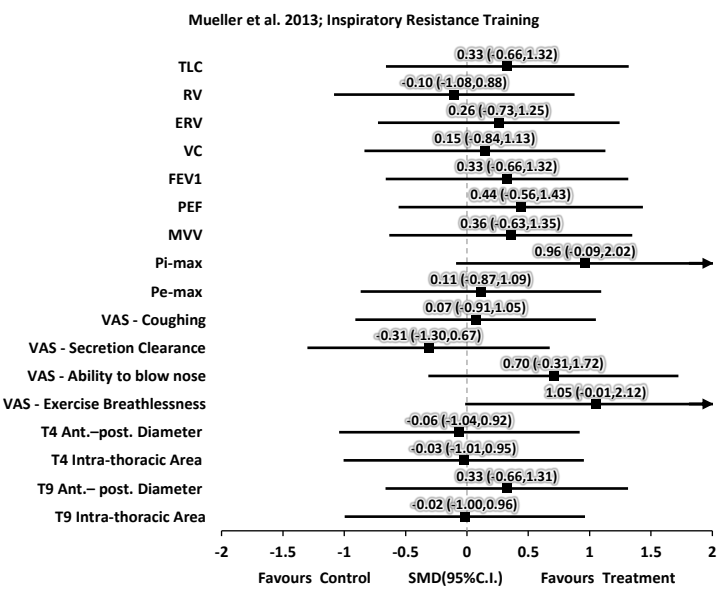
</table>

Level 2 N = 10	**Treatment:** IMT group (5): 6-week IMT; Placebo group (5). **Outcome Measures:** Diaphragm thickness, MIP, MEP, FEV_1, PIF rate, PEFR, MVV and other cardiovascular and physiological measures.	2. Significant increase in MVV for both groups; increase insignificant between-groups 3. No evidence of activity-related dyspnea in either group pre- or post-intervention 4. No correlation between percentage change in diaphragm thickness and maximum static inspiratory pressure.
Fischer et al. 2014 Italy Case control Level 4 N = 12	**Population:** 12 hand bike athletes with SCI (10M, 2F) Mean (SD) age: 43 (5.4) years Median (SD) DOI: 16.4 (7.3) years All lesions between T2-T12. **Treatment:** Control (5): no intervention; Experimental (7): 20 sessions of respiratory muscle endurance training. **Outcome Measures:** VC, FVC, TV, maximal TV, FEV_1, FEV_1/FVC, PEFR, MVV, maximal V_E ($V_E$max), maximal fb (fRmax), respiratory endurance time and other physiological measures.	1. No significant between group changes in all resting lung function measurements. 2. Significant within-group increase in fRmax, VEmax & respiratory endurance time after respiratory muscle endurance training only.
Aslan et al. 2016 USA Case control Level 3 N = 11	**Population:** 11 participants with SCI (8M, 3F) Mean (SD) age: 32(9) years Median (SD) DOI: 53(72) months 10 cervical, 1 thoracic AIS-A/B/C: 3/4/4 **Treatment:** 1 month of RMT. **Outcome Measures:** FVC, FEV_1, MIP, MEP, respiratory rate, and other physiological measures.	1. Significantly increased FVC after RMT. 2. No significant changes in other pulmonary measures.
Tamplin et al. 2013 Australia RCT PEDro = 8 Level 1	**Population:** 24 participants with chronic tetraplegia (C4-C8, AIS A & B) were randomized to the experimental group (n=13) or control group (n=11). *Intervention group*: mean (SD) age: 44 (15) yrs; DOI: 13(7) yrs. *Control group*:	1. The singing group increased projected speech intensity and maximum phonation length significantly more than the control group.

N = 24	mean (SD) age: 47(13) yrs; DOI: 8(6) yrs. **Treatment:** The experimental group received group singing training 3 times weekly for 12 weeks. The control group received group music appreciation and relaxation for 12 weeks. Assessments were conducted pre, mid-, immediately post-, and 6-months postintervention. **Outcome measures:** Standard respiratory function testing, sEMG from accessory respiratory muscles; sound pressure levels during vocal tasks, assessments of voice quality, voice handicap index, profile of mood states, and assessment of QOL.	2. Both groups demonstrated an improvement in mood, which was maintained in the music appreciation and relaxation group after 6 months. 3. No change in respiratory muscle strength was shown.
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data. 	
Van Houtte et al. 2008 Belgium RCT PEDro = 8 Level 1 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.	1. Significant increase in MIP, VC, MVV, and respiratory muscle endurance and lung volumes after IMT. 2. Number of RI was less in the training than the sham group (1 vs. 14).

	Outcome measures: MIP, VC, MVV, respiratory muscle endurance, RI.	
Mueller et al. [2012](#) & [2013](#) Switzerland RCT PEDro = 5 Level 2 N = 24	**Population:** 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. **Outcome measures:** Inspiratory and expiratory muscle strength.	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 QOL (d=0.84). 2. IH compared with placebo showed a high effect size for breathlessness 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. 	

		
Loveridge et al. 1989 Canada RCT PEDro = 5 Level 2 N = 12	**Population:** 12 participants with complete motor loss below C6-C7 (n=6 control, n=6 training) >1yr post injury, mean(SD) age IMT:31(4.1) yrs, Controls: 35(12) yrs. **Treatment:** Resistive IMT without target at 85% maximal sustainable mouth pressure (SIP) for 15 min twice daily, 5 days per wk × 8 wks. **Outcome measures:** Spirometry.	1. Increase in MIP and SIP in both the control group (30%±19% and 31%±18% respectively), and IMT group (42% ± 24% and 78% ± 49% respectively) but no difference in post-training improvements between groups. 2. The increased MIP and SIP resulted in a slower and deeper breathing pattern and a significantly shorter inspiratory time: total time of respiratory cycle in both trainers and control participants.
Litchke et al. 2012 USA Pre-post Level 4 N = 24 (22 SCI)	**Population:** 24 males (22 with tetraplegia, 1 with spastic cerebral palsy, and 1 with congenital upper and lower limb deformities) randomly assigned to 1 of 3 groups: 1) inspiratory and expiratory resistive training (n=8); 2) inspiratory and expiratory threshold training (n=8); 3) controls (n=8). Age range: 17-35 yrs; DOI range: 6 months to 17 years.	1. 16 participants completed the study (Threshold=4, Resistive=5, CON=7). 2. Resistive RMT showed reductions in bodily pain and improvements in vitality domains of the SF36 vs. CON values. The mechanism of decreased pain because of RMT is difficult to determine. However, due to the significance of pain on

	Treatment: Resistive group trained with the Expand-a-Lung;1 set of 10 breathing cycles 3x per day for 9 weeks. Threshold group trained with the PowerLung Performer model; 3 sets of 10 breathing cycles 3 times per day every day for 9 weeks. **Outcome measures:** SF-36v2	HRQOL, this outcome is worthy of further consideration.
Uijl et al. 1999 Netherlands Prospective controlled trial Level 2 N = 10	**Population:** 10 participants recruited; 9 participants completed (8M 1F), all with tetraplegia C3-C7, 2-27yrs post-injury; AIS A (n=3), B (n=3), C and D (n=3); Age: mean 34.4 yrs (range 20-49 yrs). **Treatment:** No resistive sham training (6 weeks) then Target flow IMT (6 weeks). 15 min twice daily for each phase of 6 wks. **Outcome measures:** Spirometry, MIP, Maximal incremental threshold load (TL_{max}).	1. TL_{max}, a measure of inspiratory muscle endurance increased after both sham training and IMT. 2. No significant improvement in MIP for either group or differences in post-training change between groups. 3. Significant increase in peak power, V_T and VO_2 during maximal exercise test at 6-12wks of IMT.
Rutchik et al. 1998 USA Pre-post Level 2 N = 9	**Population:** 9 people with SCI; C4-C7; >1 yr since injury; Age: 24-65 yrs with mean 36 yrs **Treatment:** Resistive IMT without target 15 min twice daily × 8 wks. **Outcome measures**: MIP, spirometry.	1. Significant increase in MIP and lung volumes after IMT. 2. At 6 months, 4 months after training stopped, trends towards baseline and repeat measures in 7 of 8 participants showed no difference between baseline and 6 months outcomes. 3. Compliance ranged between 48 and 100% of IMT sessions.
Hornstein & Ledsome 1986 Canada Case series Level 4 N = 20	**Population:** 20 participants (18M 2F) in acute post-traumatic phase; 10 tested at 4 months, 10 others were discharged, non-compliant or had medical complications.	1. Four months after IMT began, 10 participants showed improvement in MIP from mean (SD) 45(4.1) mmHg to 59(6.8) mm Hg but no statistics were performed on data.

	Treatment: Resistive IMT without target 15min 2x/day ×6wks. **Outcome measures**: MIP.	2. Two case reports showed improvement in MIP and decreased dyspnea.