Author Year Country PEDro Score Research Design Total Sample Size	Methods	Outcome
Exercise		
Middaugh et al. 2013 USA RCT PEDro=5 N=15	**Population:** Mean age=38yr; Gender: males=12, females=3; Level of injury: paraplegia=13, quadriplegia=2; Mean time post injury=16yr; Type of pain: musculoskeletal. **Treatment:** Individuals using wheelchairs were randomized to an exercise program alone (control, n=7) or with EMG biofeedback (treatment, n=8). Exercise programs were taught in two 90min sessions and were to be performed at home (1x/d, 5d/wk, 10wk). EMG biofeedback training was provided in 4 sessions (90min). Outcomes were assessed at baseline, 10wk, and 6mo. **Outcome Measures:** Wheelchair User Shoulder Pain Index (WUSPI).	1. The treatment group had a significant reduction in WUSPI score at 10wk (Δ=64%, p=0.02) while the control group did not (Δ=27%, p=0.42). 2. There were significant reductions in WUSPI score at 6mo in both the control group (Δ=63%, p=0.03) and treatment group (Δ=82%, p=0.004).
Ginis et al. 2003 Canada RCT PEDro=6 N=34	**Population:** SCI: Mean age=38.6 yr; Gender: males=23, females=11; Severity of injury: complete=14, incomplete=13. Type of pain=neuropathic and musculoskeletal. **Treatment:** Participants in the non-exercise group were asked to continue their usual activities but they were asked not to exercise regularly. Those in the exercise group participated in 5 min of stretching, 15-30 min of aerobic arm ergometry exercise and 45-60 min of resistance exercise. These subjects trained 2x/wk in small groups. **Outcome Measures:** Pain perception (two items from the Short form-36 Health Survey), symptom self-efficacy and perceived control (two core items from the Beliefs scale and a modified version of the arthritis belief scale), stress was measured using the perceived stress scale.	1. After 3 mo, changes in potential mediators were seen in: • The treatment group showed a significant decrease in stress (p=0.01) and pain (p=0.03) than the control group. • The two groups for QoL (p=0.007); satisfaction with physical function (p<0.01); satisfaction with physical appearance (p=0.007); depression (p=0.02). 2. Stress and pain (mediators of QoL): • Once baseline pain and stress were controlled for, the 3 mo scores for pain was (R2=.15, p<0.01) and for stress it was (R2=0.12,p<0.01). • These were significant predictors of baseline adjusted 3 mo QoL. 3. Stress and pain as mediators of depression: • Changes in pain but not stress explained significant variance in baseline adjusted depression scores (R2=0.19 and 0.04). • Adjusted pain scores showed variance in the adjusted 3 mo depression scores (R2=0.19 and <0.01).
Curtis et al. 1999 USA RCT PEDro=5 N=42	**Population:** Mean age=35 yr; Gender: males=35, females=7; Level of injury=cervical to lumbar; Duration of wheelchair use=24 yr. Type of pain=nociceptive. **Treatment:** The experimental group attended a 60 min educational session	1. When looking at the effect of exercise intervention on performance corrected (PC) WUSPI, a two factor repeated measures ANOVA showed a significant effect of time only (p=0.048).

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	where they were instructed in five shoulder exercises. **Outcome Measures:** Self-report questionnaire (demographic and medical info), Wheelchair User's Shoulder Pain Index (WUSPI), and Visual Analogue Scale (VAS) used to rate intensity of pain.	2. There were no significant differences between control and experimental group in age, years of wheelchair use or activity levels although the control group had much lower pain scores at baseline.
Nawoczenski et al. 2006 USA Prospective Controlled Trial N=41	**Population:** Exercise group: Mean age=47.1 yr; Gender: males=15, females=6, Level of injury: C=3, T2-T7=7, T8-T12=7, L=4; Severity of injury: incomplete=13, complete=8; Control group: Mean age=38.1 yr; Gender: males=13, females=7, Level of injury: T2-T7=7, T8-T12=12, L=1; Severity of injury: incomplete=6, complete=14; Type of pain=musculoskeletal. **Treatment:** Those in the experimental group (n=21) were given an 8 wk home exercise program consisting of stretching and strengthening exercises. This program was augmented at 4 wk (or sooner). Changes included increasing elastic band resistance, increasing repetitions, or both. The asymptomatic control group (n=20) was not given any exercises. **Outcome Measures:** Wheelchair User's Shoulder Pain Index (WUSPI); Shoulder Rating Questionnaire (SRQ)	1. SRQ and WUSPI scores significantly improved in the experimental group, pre- to post-test ($p<0.001$ and $p=0.002$, respectively). 2. Over time, satisfaction scores in the intervention group significantly improved ($p<0.001$).
Crane et al. 2017 USA Pre-Post N_{start}=89 N_{finish}=45	**Population:** Mean age=43.8±15.3 yr; Gender: males=34, females=11; Time since injury=1.0-21.0 yr; Severity of injury: AIS A/B=23, C/D=22; Type of pain=undifferentiated. **Intervention:** Participants engaged in a physical therapy group exercise class twice/wk for 3 mo. **Outcome Measures:** Exercise frequency and intensity, perceived health (EuroQOL), pain (bodily pain sub scale from short form-36), mood (PHQ-2 depression rating), sleep and television watching habits.	1. Significant increase in days per week of strenuous and moderate exercise ($p=0.01$) along with a significant improvement in state of health ($p=0.05$) from baseline to post-intervention. 2. No significant difference between baseline and post-intervention for days per week of mild exercise ($p=0.08$), hours of TV watching per week ($p=0.10$), PHQ-2 score ($p=0.19$) or bodily pain sub scale ($p=0.24$).
Serra-Ano et al. 2012 Spain Pre-Post N=15	**Population:** Age=26-70yr; Gender: males=15; Severity of injury=complete. Type of pain=nociceptive. **Treatment:** SCI individuals with chronic shoulder pain participated in an 8 week resistance training program with 3 sessions per week. **Outcome Measures:** Wheelchair User's Shoulder Pain Index (WUSPI)	1. Significant decrease in pain intensity was reported post treatment ($p<0.05$). 2. Upper limb functionality including rotation, flexion and extension improved significantly post treatment ($p<0.05$).
Finley & Rodgers 2007 USA Pre-Post	**Population:** Mean age=46 yr; Gender: males=9, females=8; Mean duration of wheelchair use=15 yr; Type of disability:	1. Shoulder ROM, upper-extremity strength, or the occurrence of specific shoulder diagnoses did not

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N=17	SCI=9, spina bifida=1, ataxia=1, postpolio syndrome=1, spinal stenosis=1, stroke=1, rheumatoid arthritis=1; Type of pain=musculoskeletal. **Treatment:** 4 wk baseline phase where patients used personal wheelchairs (no intervention), followed by a 5 mo phase where patients used the intervention wheelchair (MAGICWheels 2-gear wheel). There was a 4 wk retention period in which patients used their personal wheels again. Once a day patients were instructed to navigate in uneven terrain or on a hill. **Outcome Measures:** Wheelchair User's Shoulder Pain Index (WUSPI), WUFA, self-reported activities (Activities Log), and timed hill climb test with Rating of Perceived Exertion (RPE).	differ after use of MAGICWheels ($p<0.05$). 2. Shoulder pain was significantly decreased following the treatment at wk 2 ($p=0.004$) through wk 16 ($p=0.015$). 3. At wk 20, one patient reported increased pain from unrelated factor. 4. During the 4 wk retention phase, the WUSPI scores indicated a trend toward increasing shoulder pain. However, no significant increase was found compared to the last week of using the MAGICWheels ($p<0.05$). 5. During the MAGICWheels phase, patients encounter significantly more carpeted ($p<0.01$) and grass ($p<0.001$) surfaces in comparison to the baseline phase. 6. During the retention phase patients encountered significantly more hills ($p=0.009$) and gravel ($p=0.03$) surfaces in comparison to the baseline phase. 7. No difference was found in WUFA following the use of the 2-gear wheel ($p=0.06$). 8. There was significantly longer hill time during the use of the 2-gear wheel ($p=0.01$), however no difference was found in the RPE ($p=0.013$).
Nash et al. 2007 Netherlands Pre-Post N=7	**Population:** Age=39-58 yr; Level of injury=T5-T12; Severity of injury=complete; Type of pain=musculoskeletal. **Treatment:** Seven participants volunteered to undergo 16 weeks of circuit resistance training (CRT), 3 times weekly on non-consecutive days, each session lasting 45 min. Included were: circuit resistance training, low-intensity endurance activities, military press, horizontal rows, pectoralis (horizontal row), preacher curls, wide-grip latissimus pull-downs, and seated dips. **Outcome Measures:** Wheelchair User's Shoulder Pain Index (WUSPI).	1. Participants reported a reduction in pain. WUPSI scores decreased from 31.8±23.5 to 5.0±7.7 ($p=0.008$). 3/7 participants reported near-complete resolution of shoulder pain following treatment. 2. All completed training, with peak Vo_2 values increasing from 1.64±0.45 to 1.81±0.54L/min ($p=0.01$). 3. Anaerobic power increased significantly as a result of training; peak power increased by 6% and average power by 8.6% ($p=0.005$ and $p=0.001$, respectively).
Ditor et al. 2003 Canada Pre-post N=7	**Population:** SCI: Mean age=43.3 yr; Gender: males=5, females=2; Level of injury: C5-T12; Severity of injury: AIS A, B; Time since injury=3-23 yr; Type of pain=neuropathic.	1. There was a significant decrease in exercise adherence over the 3 mo follow-up period in comparison to the 9-month adherence rate (42.7% vs. 80.65%, respectively; $p<0.01$).

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	Treatment: Patients previously part of a 9 mo exercise training, given for 3 mo, 2x/wk of continued supervised exercise training in a laboratory setting. **Outcome Measures:** Exercise adherence (% of available sessions that were attended [max. 2x/wk]), Perceived Quality of Life Scale (PQOL), Pain (2 pain items from the Short form-36 Health Survey), Perceived Stress Scale ([PSS).	2. At 3 mo follow-up, there was a significant decrease in PQOL ($p<0.05$). 3. Also, a trend was found for increased pain ($p=0.07$) and stress ($p=0.12$). 4. There was a significant negative correlation between pain scores at the completion of the 9-month study and adherence during the 3-month follow-up ($R=-0.91$; $p<0.01$).
Exoskeleton		
Baunsgaard et al. 2018 Denmark Pre-Post N=52	**Population:** Mean age=35.8 yr; Gender: males=36, females=16; Time since injury: recently injured (≤1 yr)=25, chronically injured (>1 yr)=27; Level of injury: motor complete tetraplegia=3, motor incomplete tetraplegia=11, motor complete paraplegia=22, motor incomplete paraplegia=16; Severity of injury: AIS A/B=36, C/D=16; Type of pain=neuropathic and nociceptive. **Intervention:** Participants engaged in gait training three times/wk for eight wks via an Ekso GT robotic exoskeleton (Ekso Bionics). **Outcome Measures:** Pain (International SCI Pain Basic Data Set (ISCI-PBDS), spasticity (modified ashworth scale (MAS), range of motion (ROM) (goniometry), spinal cord independence measure (SCIM III) and bowel, lower urinary tract function and quality of life (QOL) (ISCI-basic data set).	1. 40% of the participants experienced pain at all assessment time points, 29% reported pain at 1, 2 or 3 time points and 31% reported no pain at all. 2. No significant difference in either group from baseline to wk 8 regarding pain during day-to-day activities, overall mood, ability to get a good night's sleep or number of pain problems experienced the previous week ($p>0.05$). 3. 7 participants reported neuropathic pain, 15 reported nociceptive pain, and 4 reported they experienced both. 4. Areas where nociceptive pain was reported were the lower back, upper back, shoulder, and knee, whereas neuropathic pain was reported at the thought and lower extremity as well as the lower back and hip. 5. No difference in ROM detected from baseline to wk 8 or to follow-up ($p>0.05$). 6. SCIM III scores improved significantly in the recently injured and chronically injured groups ($p<0.05$ for both). 7. Improvements seen within the ISCIBDS awareness of the need to defecate for 6 of 25 participants in the recently injured group, and none in the chronically injured group. 8. No significant change in QOL for the recently injured group, but significant improvements for QOL in the chronically injured group from baseline to wk 8 ($p=0.03$) and follow-up ($p=0.01$).
Stampacchia et al. 2016 Italy Pre-Post N=21	**Population:** Mean age=48.1±12.3 yr; Gender: males=17, females=4; Time since injury=122.7±104.8 mo; Level of injury: C=4, T(D)=13, L=4; Severity of	1. Standing time was positively correlated with walking time ($p<0.002$) and number of steps ($p<0.0001$).

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	injury: AIS A=12, B=2, C=0, D=7; Type of pain=neuropathic. **Intervention:** Participants engaged in a powered robotic exoskeleton walking session. **Outcome Measures:** Standing time, walking time, number of steps, numeric rating scale (NRS), modified Ashworth scale (MAS) and Penn spasm frequency scale (PSFS) for muscle spasticity, NRS for pain, patient's global Impression of change (PGIC) scores and PGIC visual analog scores (VAS) and positive and negative sensations questionnaire.	2. Spasticity scores were significantly reduced for NRS ($p<0.001$), MAS ($p<0.001$), and PSFS ($p<0.001$). 3. Average pain scores across all participants did not change significantly ($p=0.094$), but the effect size was low. 4. Across only patients that reported pain before the robot-assisted session (n=12) there was a significant pain reduction ($p=0.002$), with no significant change in pain scores for those who did not report pain before the session (n=9) ($p=0.25$). 5. Reduction of pain was not correlated with reductions in spasticity ($p>0.05$). 6. PGIC scores and PGIC VAS scores indicated that patients did experience a moderate change. 7. Significant negative correlation between the two subscales of the questionnaire was observed ($p<0.0001$), showing high positive sensation scores and low negative sensation scores.
Yoga		
Curtis et al. 2017 Canada RCT Crossover PEDro=6 N=22	**Population:** Yoga group (n=10): Mean age=47.9±19.5 yr; Gender: Not reported; Level of injury: paraplegia=6, tetraplegia=0, ambulatory/unspecified=4; Severity of injury: complete=2, incomplete/disease-related=8. Control group (n=12): Mean age=54.8±10.1 yr; Gender: Not reported; Level of injury: paraplegia=4, tetraplegia=4, ambulatory/unspecified=4; Severity of injury: complete=5, incomplete/disease-related=7; Type pf pain=neuropathic and nociceptive. **Intervention:** Participants were randomized to a 6 wk, twice wkly Iyengar yoga group or a 6 wk wait-listed control group, then after the first yoga group completed their sessions, the wait-list control group engaged in the yoga protocol. **Outcome Measures:** Pain (brief pain inventory (BPI), pain catastrophizing scale (PCS)), psychological (acceptance and action questionnaire (AAQ), hospital anxiety and depression scale (HADS), general self-efficacy scale (GSES), posttraumatic growth inventory (PTGI-SF), Connor-Davidson resilience scale (CD-RISC), self-compassionate scale (SCS)) and mindfulness (five-facet	1. Yoga group had significantly lower scores for the HADS ($p<0.05$) and significantly higher scores for the SCS ($p<0.05$) at post-intervention than at baseline. 2. Fixed-factor models showed significantly lower HADS scores postintervention compared to preintervention ($p<0.05$) with time being the main predictor of HADS scores ($p<0.05$). 3. There was a trend noticed for FFMQ scores from preintervention to postintervention for total scores ($p=0.09$) and observing scores ($p=0.06$). 4. Postintervention scores for the SCS and FFMQ were both significantly higher than at preintervention ($p>0.05$).

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	mindfulness questionnaire (FFMQ) measures taken 1-2 wks before and after the program.	