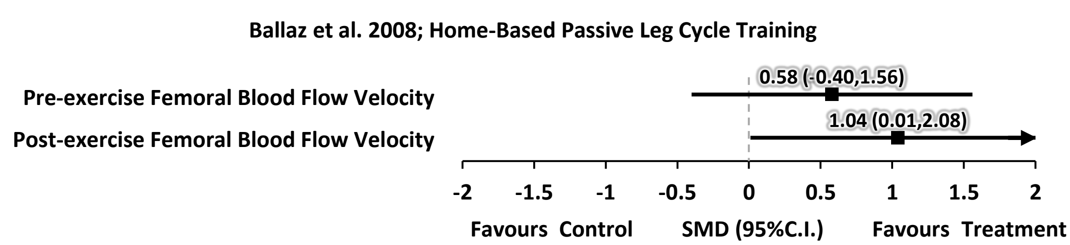
<table>
<tr><th>Author Year;
Country
Score
Research Design
Sample Size</th><th>Methods</th><th>Outcomes</th></tr>
<tr><td colspan="3">Active Stand Training</td></tr>
<tr><td>Harkema et al. 2008;
USA
Pre-Post
Level 4
N = 8</td><td>Population: 8 participants with tetraplegia or paraplegia
Treatment: Active stand training for 40 and 80 sessions.
Outcome Measures: Ability to bear weight, blood pressure and heart rate (at rest and in response to an orthostatic challenge).</td><td>1. All participants were able to bear more weight after training.
2. There was a significant increase in resting blood pressure in persons with tetraplegia after 80 training sessions (by 24%).
3. Orthostatic tolerance was improved in persons with tetraplegia (i.e., orthostatic hypotension was no longer present after 80 sessions).
4. There were no significant changes in hemodynamic parameters in persons with thoracic SCI.</td></tr>
<tr><td colspan="3">Passive Cycling Exercise</td></tr>
<tr><td rowspan="2">Ballaz et al. 2008;
France
PEDro = 6
RCT
Level 1
N = 17</td><td>Population: 17 participants with chronic paralegia (mean age 48 ± 8, range 35-62), divided into experimental (n = 9) and control (n = 8)
Treatment: passive cycling exercise 6 times weekly for 6 weeks
Outcome Measures: Red blood cell velocity in the common femoral artery; Velocity index (a measure of peripheral vessel resistance) was measured before and after a 10-min session of passive cycling exercise.</td><td>1. Before training, the resting mean blood flow velocity did not differ between groups.
2. In the experimental group, the post-exercise mean blood flow velocity was significantly higher after training.
3. Post exercise velocity index was significantly lower in experimental group after training.</td></tr>
<tr><td colspan="2">Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data
</td></tr>
<tr><td colspan="3">Prolonged Intense Multi-Modal Exercise (IE)</td></tr>
<tr><td>Harness et al. 2008;
USA
Prospective Controlled Trial
Level 2
N = 29</td><td>Population: 29 SCI participants, divided into intense exercise (n=21, age 37.8 ± 3.6 y, 40 ± 7 months post-injury) and control (age 34.5 ± 2.9 y, 97 ± 23 months post-injury)
Treatment: Intense exercise group: regular participation in an individually designed exercise multi-modal program focused on regaining voluntary motor function below the level of injury for 6 months; participants in the control group dictated their own level of activity
Outcome Measures: AIS scores; Medical Research Council scale (a measure of muscle strength)</td><td>1. The intense exercise group showed significantly greater gains for total AIS motor score compared to the control.
2. 15 participants in the intense exercise group, compared to 0 in the control, had at least one muscle increase in strength from 0 to 1 or more on the Medical Research Council scale.
3. 7 participants in the intense exercise group, compared to 1 in the control, had at least one muscle increase in strength from <3 to ≥3.</td></tr>
</table>

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Quad Rugby		
Hopman et al. 1996; The Netherlands Pre-post Level 4 N=21	**Population:** Participants divided into 3 groups according to their fitness levels. All participants had a cervical SCI (C4 to C8), tetraplegia. 1. Trained group (T) (n=8): All males; Age: 32.7±12.7; Time since injury: 8.1±10.3; Type of injury: 4 incomplete, 4 complete 2. Untrained group (U) (n=7): 6 males and 1 female; Age: 26.6±6.9; Time since injury: 6.6±5.2; Type of injury: All complete 3. Sedentary group(S) (n=6): 4 males and 2 females; Age: 36.5±10.4; Time since injury: 9.1±3.9; Type of injury: All but one with complete lesion **Treatment:** Untrained and trained group trained once a week and played 2 games/month for 6 months. Training consisted of endurance, sprint, and skill training. The U trained 42.2 min and T 21.3 min above 60% HR_{res} during training. **Outcome Measures:** Physiological responses to maximal and submaximal arm-cranking exercise.	1. No significant differences were found in either absolute or relative changes in the physiological responses to arm exercise for submaximal and maximal exercise over 3 or 6 months in U, T, and S groups.
Passive Exercises		
Ter Woerds et al. 2006; Netherlands Prospective controlled trial Level 2 N=16	**Population:** (1) SCI group: 8 males; Age: 35±8.4; Level of injury: 7 thoracic, 1 thoracic-lumbar, range T2-L1; Type of injury: 6 AIS A, 2 AIS B; Time since injury: 8.3±6.1; Hours of exercise/week: 5.7±3.9. (2) Control group: 8 males; Age: 26±4.5; Hours of exercise/week: 4.7±2.3. **Treatment:** Each participant successively underwent 2 interventions, passive leg movements (10 minutes) and passive cycling (20 minutes). **Outcomes measures:** Leg blood flow, mean red blood cell velocity, diameter of common femoral artery, leg vascular resistance, mean arterial pressure, total peripheral resistance.	1. Blood flow, vascular resistance, and blood pressure in the common femoral artery did not change during or after 2 different passive exercise interventions in the participants with SCI or the control participants.
Wheelchair skills + weight training		
Durán et al. 2001; Colombia Case series Level 4 N=13	**Population:** 12 males and 1 female; Age: 26.3±8.3; Level of injury: All thoracic, T3-T12; Time since injury: 2-120 months; Type of injury: 11 AIS A, 1 AIS B, 1 AIS C. **Treatment:** The program lasted for 16 weeks, with a frequency of 3 sessions (120 minutes) per week. Mobility activities, aerobic resistance, strength, coordination, recreation, and relaxation were combined. The specific aerobic program lasted 11 weeks, including a 4-week adaptation and 1-week enhancement period. Progressively led to 40 minutes of aerobic	1. Pre-training FIM scores mean 106±7 vs. 113±7 post-training. Highest increase occurred in mobility. 2. Lipid profiles and average resting heart rate did not change. 3. Maximum resistance achieved during arm exercise test increased from 90±24 watts to 110±26 watts. 4. HR at 6 minutes after exercise test decreased from 115±19 bpm to 108±19 bpm.

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	training at 40% to 60% HR reserve. **Outcome measures:** FIM (functional independence measure), arm crank exercise test, lipid levels	
	Whole Body Vibration	
Yarar-Fisher et al. 2013 USA Randomized cross-over trial Level 1 N=21	**Population:** 11 males with SCI (C4-T6, ASIA- A or B) and 10 able bodied individuals **Intervention:** 3 whole body vibration (WBV) exercise sessions at 30, 40, 50 Hz. **Outcome measures:** Heart rate, mean arterial blood pressure (MAP), stroke volume (SV), cardiac output (CO), oxygen consumption (VO2), relative changes in oxygenated (HbMbO2), deoxygenated (HHbMb) and total (HbMbtot) heme groups	1. No significant interactions or main effects in either group for HR, MAP, SV, and CO. 2. Both groups demonstrated small but significant increases after WBV in VO_2, [HbMbO2] and [HbMbtot] but the response was greater in the SCI group. 3. Significant decrease in HHbMb was observed in the SCI group.
	General Physical Activity	
Totosy de Zepetnek et al. 2015 Canada PEDro=4 RCT Level 2 N=17	**Population:** 23 individuals with SCI from C3-T11. 12 randomly assigned to Physical Activity Guidelines (PAG) training and 11 maintained existing physical activity levels with no guidance or training intensity. **Treatment:** PAG training involving at least 20 minutes of moderate-vigorous aerobic exercise and 3X10 repetitions of upper body strengthening exercise at 2 times per week for 16 weeks. The control group maintained existing physical activity levels with no guidance on training intensity. **Outcome measure:** Blood biomarkers, body composition, arterial structure, arterial stiffness and function (i.e. heart rate, blood pressure, carotid pulse pressure, distensibility)	1. There were decreases in whole body mass, whole body fat, visceral adipose tissue (VAT), and carotid distensibility in the control group. Whereas, the PAG group maintained body composition and carotid stiffness. 2. No other interactions found for other measures of carotid artery structure, indices of regional artery stiffness or vascular function. PAG did not elicit changes in other CVD risk factors. 3. No change in fasting insulin, leptin, adipokines, inflammatory markers, and thrombotic markers in either group
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data	

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	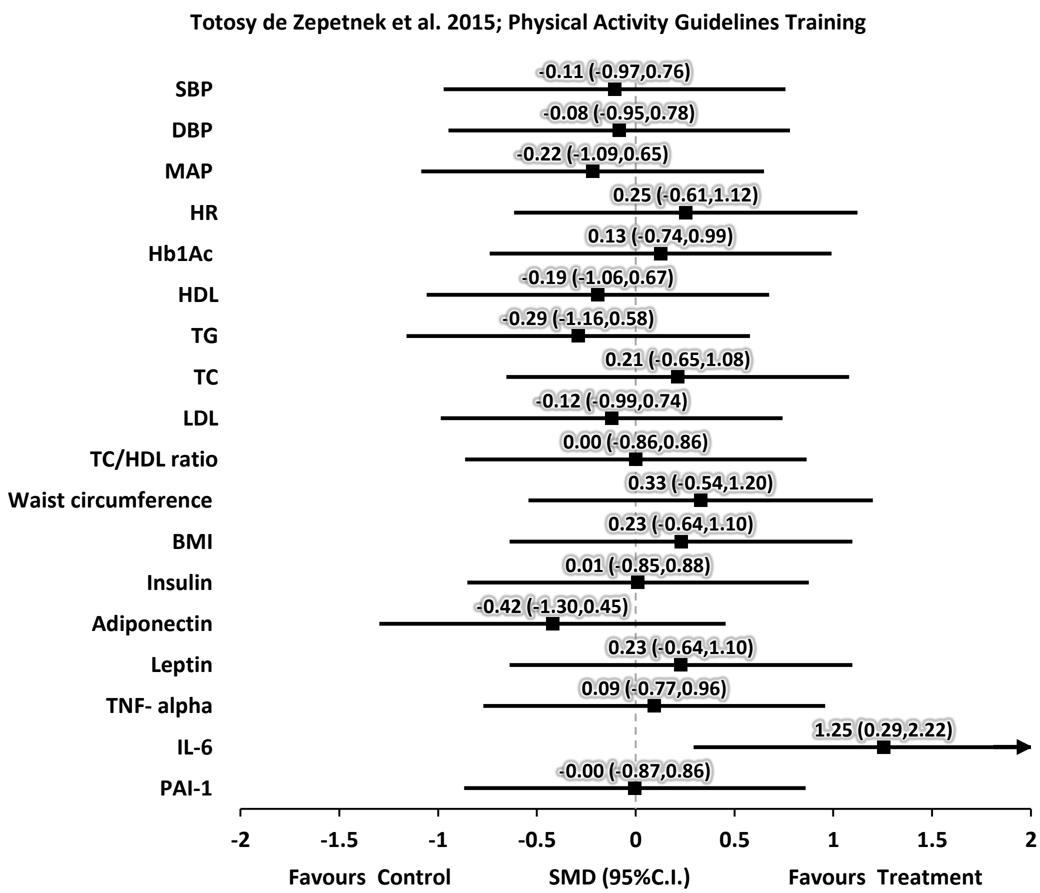	
Ravensbergen et al. 2014 Netherlands Longitudinal Level 2 N=110	**Population:** 110 participants, 74% male, 36% cervical lesion, 16% high thoracic lesion, 47% low level lesion, 59% AIS-A, 41% AIS B,C,D. **Treatment:** None. All underwent standard active inpatient rehabilitation **Outcome Measures:** Cardiovascular variables including resting systolic (SAP) and diastolic arterial pressures (DAP), resting and peak heart rates (HR peak), were measured on 5 test occasions: start of inpatient rehab, 3 months later, at discharge and at 1 and 5 years after discharge.	1. No significant change in the prevalence of hypotension during rehabilitation and for 5 years after discharge. 2. No significant change over time in SAP. DAP did not change during the period of rehabilitation but increased in the first 5 years after discharge. 3. SAP and DAP were significantly lower in those with cervical lesions compared with those with high thoracic and low level lesions. 4. No significant change over time in HR peak. HR rest decreased significantly during inpatient rehab and decreased further from time of discharge to 5 years after discharge. Lesion level was negatively associated with HR peak and HR rest and age was negatively associated with HR peak. No significant change in the prevalence of

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		bradycardia over time. Prevalence of an elevated HR improved during and after rehabilitation.
De Rossi et al. 2014 Brazil Cross-sectional study Level 5 N= 87	**Population:** 58 SCI men (29 sedentary- SCI-S and 29 athletes SCI-A) with at least 1 year of SCI, 50 SCI participants were ASIA A and 8 were ASIA B. 29 able-bodied men (AB) acted as controls. **Treatment:** None **Outcome Measures:** Cumulative training time, body mass index, blood pressure, glucose, lipid fractions, C-reactive protein. Aortic root, Left ventricle and left atrial dimensions, cardiac output, mitral inflow velocity, peak early inflow velocity, peak atrial inflow velocity, peak early/atrial velocity ratio	1. SCI-S presented similar left ventricular (LV) structural and systolic parameters but higher E/Em and lower Em/Am ratios that SCI-A and AB. 2. Tetraplegic athletes had similar features compared with sedentary tetraplegic participants, except for higher E/Em ratio and lower Em values. 3. Paraplegic athletes had similar features compared with sedentary paraplegic individuals, except for higher LV end-diastolic diameter, Em/Am ratio, stroke volume, lower heart rate and relative wall thickness. 4. No correlation detected between training time and cardiac features. In paraplegic athletes, cumulative training time correlated with stroke volume, LV end-diastolic diameter, relative wall thickness, LV mass index and LV end systolic diameter.
Serra et. al 2014 Spain Cross-sectional Level 5 N=78	**Population:** 42 paraplegic participants (T2-T12, AIS A or B) and 36 able bodied (AB) participants. **Treatment:** None. Paraplegic group went about their normal physical activities (22 participants ≥ 3 hrs/week of sport vs. 20 who was active for < 3 hrs/week) **Outcome measures:** Heart Rate variability (HRV)	1. Significant differences between paraplegic and AB participants in some variables in the time domain, frequency domain, and nonlinear analyses. 2. When power was normalized, there were no differences between the two groups. 3. There was reduced variability in paraplegic participants who adopted a sedentary lifestyle. There was only a significant difference in detrended fluctuation in heart rate variability between the sedentary and active paraplegic groups. 4. No differences in autonomic cardiac control between those with different levels of injury (above or below T6).
Schreiber et al. 2014 Cross-sectional Level 5 Brazil N=42	**Population**: 19 SCI men (sedentary- S-SCI) and 23 physically active men (PA-SCI) (ASIA A or B) **Treatment**: None. S-SCI did not perform sports, recreational activity or labor that required physical effort. PA-SCI comprised competing athletes regularly performing wheelchair sports for at least 1 year. **Outcome measures:**	1. PA-SCI participants presented lower pro-MMP-2 and pro-MMP-2/TIMP-2 levels compared to S-SCI participants.. 2. No differences in structural cardiac variables and measurements of systolic function between S-SCI and PA-SCI groups. 3. S-SCI group presented echocardiographic features of reduced LV diastolic function (lower E/A ratio and Em and higher E/Em ratio vales) in comparison with the PA-SCI group.

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	Concentration of matrix metalloproteinases (MMPS) and tissue inhibitors of MMPs (TIMPs), echocardiographic parameters (i.e. LV mass, LV diastolic function)	4. The significant difference between the 2 groups for E/A ratio, Em, and E/Em ratio became insignificant after adjustment for pro-MMP-2 levels. (This suggests that pro-MMP-2 might play a role in LV diastolic function improvements induced by regular physical activity in SCI participants.)
Currie et al. 2014 Canada Cross-sectional Level 5 N= 21	**Population:** 8 non-athletic men with SCI and 13 athletic men with SCI. All have tetraplegia (C4 –C8), traumatic motor complete cervical SCI for more than one year. **Treatment:** None. Regular hours of physical activity for both groups **Outcome measures:** Sympathetic function including palmar sympathetic skin responses (SSR) to median nerve stimulation, systolic (SPB) and diastolic blood pressure (DBP) in response to passive sit up. Peak heart rate (HR) during maximal exercise test on electrically braked arm-cycle ergometer.	1. Compared to the athletic group, the non-athletic group exhibited lower peak HR as well as greater reductions in SPB and DPB in response to passive sit-up.
Overground Training For Gait Rehabilitation		
Evans et al. 2015 USA Pre-post Level 4 N= 5	**Population**: 4 males and 1 female; average age 42 ± 9y; chronic spinal cord injury; AIS A. **Treatment**: Expired gases were collected during maximal graded exercise testing and two, 6-minute bouts of exoskeleton-assisted walking overground. **Outcome Measures:** Peak oxygen consumption (V. O2peak), average oxygen consumption (V. O2avg), peak heart rate (HRpeak), walking economy, metabolic equivalent of tasks for SCI (METssci), walk speed, and walk distance.	1. Significant differences were observed between walk-1 and walk-2 for walk speed, total walk distance, V. O2avg, and METssci 2. Exoskeleton-assisted walking resulted in %VO2peak range of 51.5% to 63.2%. The metabolic cost of exoskeleton-assisted walking ranged from 3.5 to 4.3 METssci. -Semen collected by PVS (6 pregnancies) and EEJ.
Stationary Cycling and Uphill Treadmill Walking		
Wouda et al. 2015 Norway PEDro= 6 RCT Level 1 N= 30	**Population**: 22 males and 8 females; mean age 41y; incomplete spinal cord injury; AIS D; 4-14 y post injury **Treatment**: 15 participants with incomplete SCI and 15 control participants performed sub-maximal and maximal exercise tests of both stationary cycling and uphill treadmill walking on separate days. **Outcome Measures:** VO2, VCO2, respiratory exchange ratio (RER), heart rate (HR)	1. RER was significantly higher for the SCI group during the cycle test compared to the uphill treadmill walking test. Control participants exhibited significantly higher peak VO2 during the treadmill test as compared with the cycle test.