Author, Year Country Study Design Sample Size	Population Intervention Outcome Measure	Results
(Johnston, Smith, et al., 2009) USA RCT N=30 PEDro=5	**Population:** *Original RCT (n=30):* Age: 9.7±2.5; Gender: males=17, females=13; Injury etiology: Traumatic SCI=26, Transverse Myelitis=2, Chemotherapy=1, Ischemia=1; Level of Injury: cervical=11, thoracic=19; Severity of Injury: AIS A=22, B=6, C=2. **Intervention:** Subjects were randomized to one of three groups: 1) Functional Electrical Stimulation Cycling [FESC; n=10] (50 rpm while seated in wheelchair, pulse duration=150 ls, frequency=33 Hz, amplitude max 140 mA, increased automatically to generate sufficient force to maintain the cadence); 2) passive cycling [PC; n=10] (50 rpm), or 3) non-cycling with 20 min daily surface electrical stimulation [ES; n=10] to lower extremity muscles. Sessions were conducted for 1 hr/day, 3 days/wk for 6 mo. **Outcome Measures:** Heart rate (HR), oxygen consumption (VO_2/kg) under four conditions (pre-exercise, warm-up, activity to fatigue, recovery), Forced Vital Capacity (FVC), Lipid Profile (i.e., high density lipoprotein [HDL], low density lipoprotein [LDL], cholesterol, triglycerides).	1. There were no significant differences between groups in VO_2/kg, HR, FVC or any of the lipids between baseline and the 6 mo follow-up.
(Johnston, Smith, et al., 2008b) USA RCT* N=4 *Subjects were a subset from the larger RCT by (Johnston, Smith, et al., 2009)	**Population:** *Case 1:* 7 yr, female, T4-T6, ASIA A SCI at 2 yr of age; *Case 2:* 9 yr, female, C7, ASIA A SCI at 4 yr of age; *Case 3:* 7 yr, male, T3, ASIA A SCI at 3 yr of age; *Case 4:* 11 yr, male, C7, ASIA A SCI at 3 yr of age. **Intervention:** Subset of patients randomized to one of two groups: 1) Functional Electrical Stimulation Cycling [FESC] at 50 rpm while seated in wheelchair (pulse duration (150 ls) and frequency (33 Hz) were fixed; current amplitude (max 140 mA) increased automatically to generate sufficient force to maintain the cadence), or 2) Passive cycling at 50 rpm. Sessions were conducted for 1 hr, 3 times/wk for 6 mo. **Outcome Measures:** Bone mineral density (BMD) using Dual Energy X-ray Absorptiometry (DEXA) of the left femoral neck, distal femur, and proximal tibia; left quadriceps muscle volume using magnetic resonance imaging (MRI); electrically stimulated strength of the left quadriceps using a dynamometer; spasticity of the quadriceps and hamstrings muscles using Ashworth scale scores; fasting lipid profile via high density lipoprotein (HDL) and low-density lipoprotein (LDL); heart rate (HR); and oxygen consumption (VO_2/kg).	*Case 1: FESC* 1. Improvements in BMD at the femoral neck, distal femur, and proximal tibia; quadriceps muscle volume; stimulated strength of the quadriceps muscles; HDL cholesterol; resting HR; peak VO_2/kg; and peak HR; however, cholesterol, LDL, and triglyceride levels and the cholesterol/HDL ratio increased compared to baseline. 2. No changes in Ashworth scores, but parents reported decreased spasticity and looser muscles. *Case 2: FESC* 3. Improvements in BMD at the femoral neck, distal femur, and proximal tibia; quadriceps muscle volume; stimulated quadriceps muscle strength; and hamstring muscle spasticity; however, cholesterol, LDL, HDL, and triglyceride levels and the cholesterol/HDL ratio worsened as compared to baseline. 4. The parents reported bigger, firmer muscles; decreased bowel program completion times; increased appetite; and increased spasticity that did not require medical intervention. *Case 3: PC* 5. Improvements in femoral neck BMD, hamstring spasticity, and triglyceride levels. 6. Distal femur and proximal tibia BMD and stimulated quadriceps strength were lower as compared to baseline,

		and LDL levels and the cholesterol/HDL ratio were elevated. 7. Parents reported decreased bowel accidents and new sensation in his knees and stomach. *Case 4: PC* 8. Improvements in BMD at the femoral neck, distal femur, and proximal tibia; quadriceps muscle volume; stimulated quadriceps strength; hamstring spasticity; cholesterol; LDL cholesterol; resting HR; and peak VO_2/kg. 9. HDL cholesterol decreased as compared to baseline but the cholesterol/HDL ratio was unchanged. 10. Parents reported decreased spasticity, looser muscles, increased energy, decreased lower extremity swelling, and increased appetite.
(Johnston, Smith, Betz, et al., 2008) USA Observational N=29 *Subjects were a subset from the larger RCT by (Johnston, Smith, et al., 2009)	**Population:** Age: 9.7±2.5 yr; Gender: males=17, females=12; Injury etiology: Traumatic SCI=24, Transverse Myelitis=1, Other=4; Level of Injury: C8/C9=9, T1-4=9, T5-11=11. **Intervention:** Upper extremity, tabletop ergonomic testing. **Outcome Measures:** Heart rate (HR), and oxygen consumption (VO_2/kg) under four conditions (pre-exercise, warm-up, activity to fatigue, recovery), peak power output (PO) (W_{peak}/kg).	1. For all subjects, the following peak values were obtained: • HR=149.9±31.6 beats per minute • VO_2=14.0±7.9 mL/kg • PO=1.1±0.7 W/kg 2. Differences were seen between the three injury groupings (C8-9, T1-4, T5-11): • HR peak (p=0.013) • VO_2peak/kg (p=0.041) • PO (p=0.001) 3. Differences were noted between the C8-9 group and the T5-11 group for HR peak (p=0.010), VO_2 peak (p=0.038), and PO peak (p=0.001).
(Nelson et al., 2007) USA Observational N=114 (N=20 SCI)	**Population:** *SCI Group (n=20):* Age: 16.9±3.0 yr; Gender: males=11, females=9; Time since injury: 4.8±4.0. *Spina Bifida (SB) Group (n=34):* Age: 16.3±2.5 yr; Gender: males=18, females=16; Time since injury: 16.3±2.5. *Control (CTRL) Group (n=60):* Age: 16.2±2.5 yr; Gender: males=27, females=33. **Intervention:** None. Anthropometric testing. **Outcome Measures:** Height, weight, waist circumference, percentage of trunk fat by Dual X-ray Absorptiometry, blood pressure, body mass index, fasting serum samples (glucose, insulin, triglycerides, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL); metabolic syndrome.	1. There was a significant difference in body weight between SB and CTRL, with SB weighing 14.6% less than CTRL (p<0.001) but no significant difference between SCI and CTRL or between SB and SCI. 2. Percent total body fat and trunk fat was significantly different between each group, with SB averaging 6.3% more trunk fat than SCI and 11.5% more trunk fat than CTRL (among all 3 groups, p<0.001; SB versus SCI and SB versus CTRL, p=0.004). 3. Obese SCI had been injured almost twice as long as nonobese SCI subjects (p<0.001). 4. BMI z-scores were 0.7 higher in SB than CTRL and 1.36 higher in SB than SCI (p<0.001 for both). 5. There were no significant differences in systolic BP z-scores; serum LDL, triglyceride, or cholesterol concentrations, or glucose between groups. 6. Serum HDL concentrations lower in SCI. 7. There was no significant difference in glucose between SCI and CTRL groups. 8. A total of 5.9% of SB and 5.0% of SCI subjects had no components of metabolic syndrome. 9. A total of 32.4% of SB and 35.0% of SCI subjects had 1 risk factor.

		10. A total of 61.8% of SB and 60.0% of SCI subjects had 2 risk factors of metabolic syndrome. 11. In total, 32% of SB subjects and 55 .0% of SCI subjects met the criteria for metabolic syndrome (3+ criteria). 12. There was a strong association between diagnostic group (SCI, SB, and CTRL) and presence of metabolic syndrome.
(Widman et al., 2007) USA Observational N=115 (N=19 SCI)	**Population:** *SCI Group (n=19):* Age: 16.0±3.2 yr; Gender: males=10, females=9; Level of injury: T4-6=10, T7-11=6, L1-5=3. Severity of injury: AIS A=13, AIS B=3, AIS C=1, AIS D=2. Height: males=158.0±15.4 cm, females=162.4±11.9 cm; Weight: males=65.8±23.6 kg, females=66.3±22.8 kg. Injury etiology: SCI (n=19), Spina Bifida (SB, n=37), Normal Weight Controls (CTRL, n=34), Overweight Controls (OW, n=25). **Intervention:** Upper extremity, tabletop ergonomic testing. **Outcome Measures:** Body Mass Index (BMI), shoulder and elbow strength, heart rate (HR), and oxygen consumption (VO_2/kg), power output (PO).	1. For both males and females, the CTRL group was significantly lighter than the OW, SB, and SCI groups. 2. The male and female SB and OW groups had significantly higher BMI than CTRL. 3. Percent body fat of OW, SB, and SCI groups was significantly higher CTRL group. 4. There was no significant difference in any of the peak strength values between the SB and SCI groups for either gender. 5. Both the male and female CTRL groups had significantly greater shoulder extension strength values than the OW, SB, and SCI groups of the same gender. 6. Within each gender, the SB and SCI groups had significantly lower VO_2 peak values at rest than the CTRL and OW groups did. 7. Accounting for body mass, the SB, SCI, and OW groups had significantly lower VO_2 peak/kg than the CTRL group. 8. For the males, the CTRL and OW groups reached similar max PO (86±4.4 W and 93±8.5 W, respectively), while both the SB and SCI groups reached exhaustion at significantly lower levels (62±4.9 W and 60±6.6 W, respectively) than either the CTRL or OW subjects; females showed similar relationships. 9. All of the groups reached similar peak HR but the male and female SB groups had significantly higher resting HR than the CTRL group of the same gender. 13. Mean resting HR for female SCI groups was also higher than the CTRL and OW groups.
(Liusuwan et al., 2004) USA Observational N=54 (N=27 SCI)	**Population:** *SCI Group (n=27):* Age: 10-21 yr, Gender: males=18, females, 9. Time since injury: 1-3 yr; Severity of injury: complete=3, incomplete=24, paraplegia=23, tetraplegia=4, AIS A=18, AIS B=2, AIS C=4, AIS D=3. *Able-Bodied Controls (CTRL, n=27):* Age and sex matched to SCI group. **Intervention:** None. Anthropometric Testing. **Outcome Measures: Height, weight,** Lean Tissue Mass (LTM), % Body Fat, Bone Mineral Content (BMC), Body Mass Index (BMI), body composition, Resting Metabolic Rate (RMR)	1. There was no difference in height between the SCI and control groups. 2. The weight of the SCI group was 14.5% lower than the weight of the able-bodied control group ($p<0.005$). 3. The BMI of the SCI group was 1 0.8% less than the control group ($p<0 .007$). 4. The SCI group had significantly lower mean LTM than CTRL group ($p<0.001$) and higher percent body fat ($p<0.02$) despite their reduced BMI ($p<0.010$. 5. There was a significant reduction in the BMC in the SCI group compared with the controls ($p<0 .007$). 4. The SCI group had lower RMR than the CTRL group ($p<0.001$) but there was no difference in RMR when adjusted for LTM.