Author, Year Country Study Design Sample Size	Population Intervention Outcome Measure	Results
(Johnston, Smith, et al., 2008b) USA Case Series* N=4 *Subjects were a subset from a 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:** *Intervention Group:* Functional Electrical Stimulation while cycling 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). *Control Group:* Passive cycling at 50 rpm. Sessions were conducted for 1 hr, 3 times/week for 6 mo. **Outcome Measures:** Bone mineral density (BMD) of the left femoral neck, distal femur, and proximal tibia; left quadriceps muscle volume, electrically stimulated strength of the left quadriceps, quadriceps and hamstrings muscles 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: FES Cycling* 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: FES Cycling* 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: Passive Cycling* 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: Passive Cycling* 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.
(Pierce et al., 2008b) USA Observational N=27 (N=18 SCI)	**Population:** *SCI:* Age: 9.3±2.7 (5-13) yr; Gender: males=11, females=7; Time since injury: 5.3 yr; Severity of injury: AIS A=15, AIS B=3. *Typical Development (TD; n=9):* Age:	1. There were no significant differences in peak passive torque in any muscle group at any movement velocity between children with SCI and TD. 2. For both the children with SCI and children of TD, velocity dependent

	10.0±1.6 (7-12) yr; Gender=males=7, females=3. **Intervention:** None. Measurements. **Outcome Measures:** Ashworth Scale (AS), Spasm Frequency Scale (SFS), knee flexion and knee extension velocity and peak passive torque.	increases in peak passive torque were found for the knee flexors ($p<0.001$) and knee extensors ($p<0.001$) at 15, 90, and 180 deg/s. 3. Children with TD demonstrated significantly more reflex activity of the medial hamstrings during the assessment of knee flexor spasticity at all movement velocities than did children with SCI ($p<0.05$). 4. There were no significant differences in vastus lateralis reflex activity between groups at any movement velocity during the assessment of knee flexor spasticity; however, children with TD demonstrated significantly more reflex activity of the medial hamstrings during the assessment of knee extensor spasticity with movements at 15 deg/s and 180 deg/s and significantly more reflex activity of the vastus lateralis during the assessment of knee extensor spasticity with movements at 180 deg/s ($p<0.05$). 5. For AS of the knee flexors, 8 children were scored as 0, 8 children were scored as 1, 1 child was scored as 2, and 1 child was scored as 3. 6. For AS of the knee extensors, 12 children were scored as 0, and 6 children were scored as 1. 7. For the SFS, 4 children were scored as 1, 10 children were scored as 2, and 4 children were scored as 3. 8. No significant relationships were found between the quantitative measurements of spasticity (peak passive torque at 15, 90, and 180 deg/s) and the clinical measurements (AS and SFS) for either muscle group with the exception of a significant relationship found between the SFS and peak passive torque of both the knee flexors and knee extensors with movements at 90 deg/s ($p<0.05$). 9. During the assessment of knee flexor spasticity, positive correlations were found between comparisons of peak passive torque at 15 to 90 deg/s and 90 to 180 deg/s ($p<0.05$). 10. During the assessment of knee extensor spasticity, positive correlations were found between measurements of peak passive torque at all movement velocities ($p<0.05$). 11. There were no significant correlations between AS and SFS during the assessment of knee flexor and knee extensor spasticity.
(Vogel et al., 2002b) Part II USA Observational N=216	**Population:** Age at injury: 14.1±4.0 yr; Age at interview: 28.6±3.4 yr; Gender: males=150, females=66; Time since injury: 14.2±4.6 yr; Level of injury: tetraplegia=123, paraplegia=93. Severity of injury: C1-4 ABC=41, C5-8 ABC=67, T1-S5 ABC=82, tetra/para D=26. **Intervention:** None. Survey.	1. Among the 216 subjects, 123 reported having spasticity requiring treatment. 2. Spasticity was significantly associated with older age at injury ($p=0.017$), sports-related SCI ($p=0.041$), tetraplegia ($p<0.001$), lower ASIA Motor scores ($p<0.001$), and lower total FIM ($p<0.001$) and motor FIM scores ($p<0.001$).

	Outcome Measures: Prevalence of spasticity.	