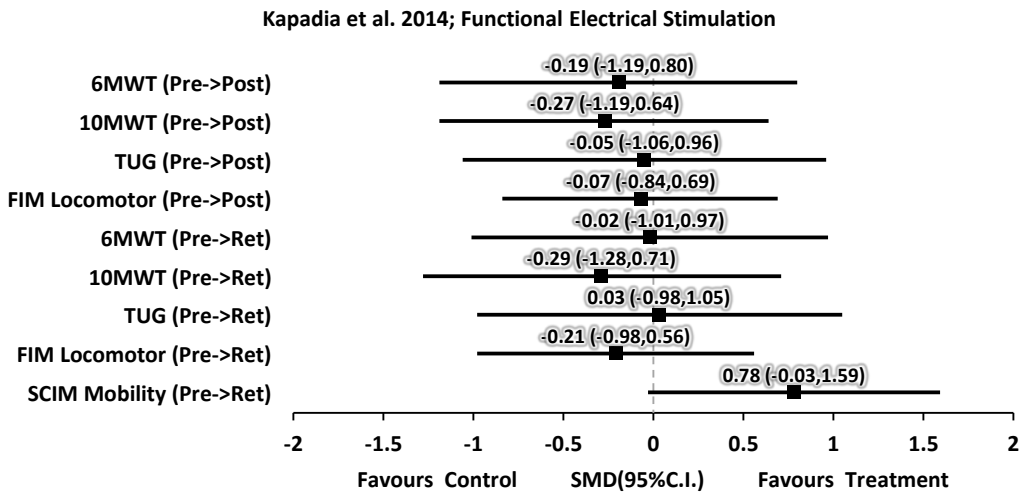
Table 14. Functional Electrical Stimulation (FES) for Standing Balance

Author Year Country Research Design Score Total Sample Size	**Methods**	**Outcome**
Galea et al. (2018); Australia RCT PEDro=7 Level 1 N=116	**Population:** 116 participants who had sustained a SCI above the level T12; 98 males and 18 females; mean age 41.45 years; level of injury C2-C8 (n=62), T1-T6 (n=31), and T7-T12 (n=23); AIS A (n=57), AIS B (n=17), AIS C (n=12), and AIS D (n=30); and mean time since injury 4.7 years. **Treatment:** The intervention consisted of 36 sessions over 12 weeks. Participants were randomly assigned to: • Full-body exercise program (n=60: Participants in received a triad of interventions comprising locomotor training (BWSTT for 30 min), FES-assisted cycling (for 10-60 min), and trunk and upper and lower extremity exercise. • Upper body exercise program (n=56): Participants received a circuit-based exercise program for the upper body, incorporating resistance and aerobic training. **Outcome Measures:** SCIM, Spinal Cord Injury–Falls Concern Scale (SCI-FCS), 6MWT, and 10MWT were assessed at baseline, 12 weeks, and 24 weeks after randomization.	1. There were no statistically significant between-group differences for 6MWT, 10MWT, SCIM, and SCI-FCS after 12 weeks of training or at 6 months follow-up. 2. AEs: 31 serious AEs (16 full-body exercise, 15 upper body exercise) and 719 minor AEs (404 full-body exercise, 309 upper body exercise) were recorded over the 6-month trial period. a. One serious AE in full-body exercise (bilateral medial femoral condyle and tibial plateau subchondral insufficiency fractures) was considered to be related to the intervention. b. Another serious AE in full-body exercise (severe worsening back pain) was considered probably related to the intervention. c. In upper body exercise, 1 serious AE (feeling off balance, pain and loss of strength in upper limbs) was considered possibly related to the intervention.
Kapadia et al. (2014); Canada RCT PEDro=5	**Population**: 27 participants; traumatic (>18 months) and incomplete chronic spinal cord lesions between C2 and T12, AIS C and D. **Treatment**: Participants were randomized to FES-assisted walking therapy	1. SCIM mobility sub-score significantly improved over time for the intervention group (p<.01) but not for the control group (baseline/12

Level 2 N=27	(intervention group) or aerobic and resistance training program (control group). 45 min of therapy per session, 3 days per week, for 16 weeks (48 sessions in total). **Outcome Measures:** Gait Measures- 6MWT, 10MWT, Assistive Device Score, Walking Mobility Scale; Balance & Mobility Measure- TUG; Functional Measures- SCIM, FIM; Spasticity Measure- Modified Ashworth Scale, and Pendulum Test were assessed at baseline, 4 months, 6 months, and 12 months post baseline.	months: 17.27/21.33 vs. 19.09/17.36, respectively). 2. On all other outcome measures the intervention and control groups had similar improvements. 3. Walking speed, endurance, and balance during ambulation all improved upon completion of therapy and the majority of participants retained these gains at long-term follow-ups.
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- to post-intervention data and pre-intervention to retention/follow-up data. 	
[Kuhn et al. (2014)](); Germany Cohort Study Level 2 N=30	**Population**: 30 participants; average age 44 ± 15.5y; motor complete and incomplete spinal cord injuries in the cervical, lumbar, and thoracic regions; AIS A=10, B=3, C=15, D=2; 0-122 months post injury. **Treatment**: During the 4-week study period, all patients received eight 20min FES interventions at the beginning and end of each week. At every intervention, circumferential measurement and spasticity testing before and after FES cycling (pretest/post-test) were performed. Ultrasound, walking tests, and manual muscle testing were only performed at the	1. For the 5 patients with partial walking ability at the start of the study, the time for TUG was reduced from 11.7±21.9 to 10.1±18.1 s (p=0.5).

	beginning of week 1 (T1) and at the end of week 4. **Outcome Measures:** Circumferential measurement, muscular ultrasound measurement, spasticity measured by Modified Ashworth Score, Walking (6MWT, TUG).	
Houston et al. (2020; 2021) Canada Pre-post Level 4 N=5	**Population:** 5 participants with chronic incomplete SCI; 1 male and 4 females; age range 55-68 years; level of injury C1 (n=1), C3 (n=1), C5 (n=1), T6 (n=1) and T10 (n=1); AIS C (n=3) and AIS D (n=2); and mean time since injury 46.8 months. **Treatment:** Participants completed three 1h training sessions per week for 4 weeks consisting of FES applied bilaterally to the ankle plantarflexors and dorsiflexors while they performed visual VFBT exercises. A closed-loop FES system was used in which the CoP was continually monitored and the level of electrical current administered was automatically adjusted. **Outcome Measures:** Outcome measures were collected before beginning the intervention, after completion of training, and 4 and 8 weeks after the intervention: • Clinical assessment: BBS, Mini-BESTest and ABC scale. • Biomechanical assessment: Static balance test (in standing) (measuring postural sway through calculation of CoP velocity and the root-mean-square of the CoP displacement in both anterior-posterior and medio-lateral directions) and dynamic balance test (in standing) (evaluating the LOS). Semi-structured interviews were conducted after completion of the balance training intervention and 8-weeks post-training to understand participants' experiences.	1. Improvements were seen for four of the five participants on at least one of the clinical scales following completion of the training intervention. 2. All participants showed greater maximal CoP excursion area during the LOS test after the training intervention, whereas only one participant demonstrated a reduction in postural sway. 3. Regarding the semi-structured interviews, risk of falling was perceived as slightly reduced or unchanged, but participants felt that their balance confidence had increased. 4. No training-related AEs were reported.