

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SI. Overview of studies using stretching: subjects, interventions, evaluation, results and level of evidence and conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results			Level of evidence (conduct score)	
		n (exp)	n (contr)								Exp	Contr	Int vs control		ICF
2003, Fragala et al. (11)	Prospective Cross-over Single-subject ABAB	7	–	4 years 2 months–18 years 2 months	GMFCS V	Phase B: intervention phase with PT and passive stretching Phase A: non-intervention phase with no stretching and no PT A (4 weeks) – B (14 weeks) – A (2 weeks) – B (6 weeks) design Stretching 3×, 40–60 s, 30 min	20	6	1.5	pROM hip (goniometer) pROM knee (goniometer)	=	↓		I	IV (9/14)
2008, Khalili & Hajihassanie (12)	Within patient-control Smaller RCT	11 (22 legs)	11	Mean 13 years (SD 1)	Diplegia knee-flexor spasticity Non-ambulant	Exp (1 leg): 30 min ES Qcps (30 Hz; pulse width 0.4 ms, 4 s on / 4 s off, ramp 0.5 s)+stretching hamstrings Contr: contralateral leg from same child: stretching	4	–	5	MAS hamstrings pROM knee ext (goniometer) Act hamstrings stretch (EMG)		↓		I	II (5/7)
2008, Lee & Ng (13)	Randomized Cross-over Single-subject Alternating treatment	29	–	4–13 years	Dystonia Hypertonia	4 sessions, random order: A 5×10 s stretching, B 5×30 s stretching, C hotpack+5×10 s stretching, D hotpack+5×30 s stretching 24 h interval	0.5	–	7	Extensibility hamstrings (distance great trochanter to lateral malleolus) PEDro scale AAPDM guidelines			↓ (BD vs I AC)	I	III (9/14)
2006, Pin et al. (14)	Systematic review	7 studies	–	–	–	MEDLINE, CINAHL, PsycINFO, Embase, Cochrane Library, PEDro ...–2006 Key words: cerebral palsy, muscle spasticity, stretching, physical therapy, range of movement	–	–	–	Level of evidence AAPDM guidelines				–	II (7)
2008, Wiert et al. (15)	Systematic review	7 studies	–	–	–	CINAHL, Embase, MEDLINE, PsycINFO, Scopus Key words: cerebral palsy, range of motion, stretching, contracture, positioning ...–2007	–	–	–	Level of evidence AAPDM guidelines				–	II (7)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; †: results were significantly higher in the experimental group or during the experimental period; ‡: results were significantly lower in the experimental group or during the experimental period; I: impairment level; ICF: International Classification of Functioning, Disability and Health; GMFCS: Gross Motor Function Classification; PT: physical therapy; pROM: passive range of motion; SD: standard deviation; HZ: Hertz; ES: electrical stimulation; Qcps: m. quadriceps femoris; MAS: Modified Ashworth Scale; Ext: extension; act: activity; AAPDM: American Academy of Cerebral Palsy and Developmental Medicine; RCT: randomized controlled trial.

Table SII. Overview of studies using massage: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results		Level of evidence (conduct)	
		n (exp)	n (contr)								Exp	Contr		Exp vs contr
2005, Hernandez-Reif et al. (16)	RCT Smaller RCT	10	10	Exp: mean 29 months SD 8 months Contr: mean 33 months SD 10 months	Ambulant Non-ambulant Spastic/athetoid Ataxia	Exp: massage, 30 min Contr: reading	12	–	2	Muscle tone flexors and extensors (MAS, ALT) pROM hip abductors and extensors (goniometer) Developmental programming for infants and young children pROM ankle dorsiflexion (goniometer) Gross motor function (GMFM) Stretch reflexes (EMG)	↓,↓ =,↓ ↑ = ↑ ↑ = =	I I A A/P I	II (3/10)	
2007, Macgregor et al. (17)	Prospective intervention Case series	5	–	12–15 years	Spastic diplegia	Massage therapy calf muscles, 14 min (Stretching the muscles transversely) (+Slow passive stretching pre-and post-massage)	5	–	2		=		A I A I	IV (3/10)
2007, Barlow et al. (18)	Prospective intervention Case series	70 parents 67 children	–	Not reported	Not reported	Training and support programme for parents (Providing parents the basic skills in massage, 8 sessions)	8	17.3	Not specified	Psychological well-being Satisfaction with Life Scale Perceived stress scales Parents' and child self-efficacy scale Parental health status Child functioning	↑ ↑ ↓ ↑ ↑ ↑	I I E E E I/A/P	IV (5/10)	
2010, Powell et al. (19)	Prospective intervention Case series	43	–	8–15 years	Not reported	Training and support programme for parents (8 weekly sessions, 1 h)	8	17.3	Not specified	Enjoyment (qualitative interviews)	↑		P	IV (2/10)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; E: environmental factors; GMFCS: Gross Motor Function Classification; PT: physical therapy; pROM: passive range of motion; RCT: randomized controlled trial; SD: standard deviation; GMFM: Gross Motor Function Measure; MAS: Modified Ashworth Scale; ALT: Arms, Legs and Trunk Muscle Tone Scale; EMG: electromyography.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SIII. Overview of studies using threshold electrical stimulation (TES): subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Method						Results			
		n (exp)	n (contr)	Age	earType	Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Exp vs Contr	Level of evidence (conduct)	
2001, Sommerfelt et al. (20)	RCT Cross-over Matched groups Smaller RCT	6	6	4–12 years Mean 8 years 8 months	Diplegia GMFCS II–III	Exp: TES year 1 (40 Hz, <10 mA, 300 μS, 5 h/night, 6 nights)+PT; usual PT year 2 Contr: TES year 2 (40 Hz, <10 MA, 300 μS, 5 h/night, 6 nights)+PT; usual PT year 1	52	52	6	Muscle strength (MMT) Ankle ROM (goniometer) Deep tendon reflexes Speed of standardized movements Gross and fine motor function (PDMS) Walking speed (6-min walk test, 6-metre walk test) Parent subjective feeling (questionnaire)	= = = = = = ↑	I I I A A I	II (5/7)
2002, Dali et al. (21)	RCT Multicentre Smaller RCT	36	21	5–18 years Mean 10 years 11 months	Hemiplegia (25) Diplegia (32) Walking	Exp: TES, 1–5 μA, 35 Hz, 0.46 μA/ 52 mm2, Qcps and Tib Ant, 6 h/night Contr: placebo (inactive stimulators) ! All children continued usual PT programme	–	–	6	Gross motor function (set of motor function tests) ROM legs and arms (goniometer) Spasticity legs and arms (MAS) Cross-stional area Qcps and Tib Ant (CT) Parent questionnaire on motor skills	= = = = = =	A I I I A	II (5/7)
2004, Mäenpää et al. (22)	Prospective Case series	17	–	3.8–8.9 years Mean 6.4 years	Hemiplegia (11) Diplegia (6)	TES of Tib Ant, 1.8×/week; 20–60 min; 10–20 Hz, 4–20 mA, 300 μs, on/off 1/1 During ordinary PT sessions	4.3	39	1.8	Active dorsiflexion, toe flex/ext, in/eversion aROM and pROM dorsiflexion Standing on 1 foot and hopping	↑ ↑ ↑	I I A	IV (3/7)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; RCT: randomized controlled trial; SD: standard deviation; GMFCS: Gross Motor Function Classification System; TES: threshold electrical stimulation; HZ: Hertz; MMT: manual muscle testing; ROM: range of motion; PDMS: Peabody Developmental Motor Scales; Qcps: m. quadriceps femoris; Tib Ant: m. tibialis anterior; MAS: Modified Ashworth Scale; CT: computerized axial tomography; flex: flexion; ext: extension; aROM: active range of motion; pROM: passive range of motion; PT: physical therapy.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SIV. Overview of studies using neuromuscular electrical stimulation (NMES): subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Subjects		Method							Results						
	Design type	n (exp)	n (contr)	Age	Type	Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Exp	Contr	Exp vs cont	ICF	Level of evidence (conduct)	
2001, Park et al. (23)	RCT Smaller RCT	14	12	8–16 years Exp: mean 16.6 years, (SD 4.4) Contr: mean 12.5 years, (SD 3.7)	Spastic diplegia	Exp: PT (NDT)+NMES abdomen and posterior back muscles; 30 min/day; 25–30 mA, 250 µs pulse width, 35 Hz; 10 s on/12 s off Contr: PT (NDT) only	6	–	6	Cobb (X-ray spine) Kyphotic angle (X-ray spine) Gross Motor Function (GMFM)	↓	=	=	I	II (3/7)	
2002, Detrembleur et al. (24)	RCT Smaller RCT	6	6	4.75–6 years Mean 5 years	Diplegia (3) Hemiplegia (9)	Exp: BTX-A+NMES calf muscles (20 Hz, 0.2 ms, 50–90 mA, 30 min, 6×/day, 3 days followed by PT) Contr: BTX-A+no adjuvant NMES, PT 2–3×/week Post BTX-A PT: strength ankle dorsiflexors, stretch calf muscles and hamstrings, gait rehabilitation	0.5	26	42	Gait (3DGA+EMG, Physicians Rating Scale) Spasticity triceps surae (MAS) Measurement of muscle stiffness ROM ankle (goniometer)			↑	A	II (6/7)	
2003, van der Linden et al. (25)	RCT Matched groups Smaller RCT	11	11	5–14 years Mean 8 years 6 months (SD 2 years 9 months)	Diplegia (14) Hemiplegia (7) Quadriplegia (1) Independent walkers	Exp: NMES glut max, 1 h/day, 10 Hz, 75 µs (week 1); 2×30 min (week 2); 1 h 30 Hz, 100 µs (week 3–6) Contr: no electrical stimulation, usual PT ! All children continued usual PT programme	8	–	6	Passive hip rotation (goniometer) Gait (3DGA) Gross motor function (GMFM) Strength glut max (myometer)				=	I	II (4/7)
2004, Maenpaa et al. (26)	Intervention Prospective Single-subject AB	12	–	4.5–16 years	Hemiplegia Moderate myocontracture triceps	Phase 1: Baseline (no intervention) Phase 2: NMES gastroc, 300 µA, 30 Hz, 5×/week, 1 h	4	–	5	aROM and pROM dorsiflexion (goniometer) ROM popliteal angle (goniometer)	↑	=		I	V (7/14)	

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SIV. Contd.

2007, Stackhouse et al. (27)	RCT Smaller RCT	6	5	8–12 years Exp: mean 10 years 7 months Contr: mean 10 years 5 months	Spastic diplegia GMFCS II–III	Exp: NMES percutaneous Pulse duration 5–200 µs, amplitude 25 mA, pulse freq 50 pps, 15 min Contr: 15 MVC Qcps and triceps s	12	–	3	MVC Qcps (dynamometer) MVC Triceps S (dynamometer) Walking speed (3DGA) Qcps cross-sectional area (MRI) Triceps S cross-sectional area (MRI)	↑ = ↑ = = ↑	↑ = = = = ↑	↑ = = = = ↑	I I A I I	II (4/7)
2007, Kang et al. (28)	RCT Smaller RCT	7	11	16 months–10 years Mean 45 months	Spastic diplegia GMFCS I–IV	Exp: BTX-A+ES gastroc (40 Hz, 0.3 ms, 10–25 mA, 30 min) Contr: BTX-A gastroc ! PT for all children, 2×/week	13	–	2	Gait (Physician's Rating Scale) Spasticity (MAS) pROM ankle and knee (goniometer) Spasticity hamstrings (MAS) pROM knee ext (goniometer)	↑ ↓ ↑ ↓ ↓	= ↓ ↑ ↓ ↓	= ↓ ↑ ↓ ↓	A I I I I	II (5/7)
2008, Khalili & Hajihassanie (12)	RCT Smaller RCT	11 (22 legs)	11	Mean 13 years (SD 1)	Diplegia Knee flexor spasticity Non-ambulant	Exp (1 leg): 30 min NMES Qcps (30 Hz; pulse width 0.4 ms, 4 s on/ 4 s off, ramp 0.5 s)+ stretching hamstrings Contr (contralateral leg from same child): 5×/week stretching	4	–	5	Spasticity hamstrings (MAS) pROM knee ext (goniometer)			↓ ↑	I I	II (5/7)
2008, Rha et al. (29)	RCT Smaller RCT	11	12	Mean 46 months (SD 18.1)	Diplegia (18) Quadriplegia (5) GMFCS I–IV	NMES post BTX-A injection Unilat: ES 25 Hz(11 children) or 4 Hz (12 children) m. gastrocnemius Unilat: Sham stimulation (7 days, 30 min/day) + 6×week usual PT	1	4.3	6	CMAP gastroc (EMG) Spasticity m. gastrocnemius (MAS)	↓ ↓	↓ ↓		I I	II (3/7)
2006, Kerr et al. (31)	RCT Placebo Smaller RCT	38	22	5–16 years Mean 11 years (SD 3 years 6 months)	Diplegia (55) Quadriplegia (1) Dystonia (1) Not class (2) Ambulant	Exp 1 (n=18): NMES, 1 h/day, 35 Hz, 300 m Exp 2 (n=20): TES, 8 h/day, 5 day/week, 35 Hz, 300 ms, <10 mA Contr (n=22): placebo	–	–	5	Peak torque Qcps (isokinetic dynamometer) Gross motor function (GMFM) Lifestyle assessment questionnaire	= = ↑	= = = ↑	= = = ↑	I A P	II (7/7)

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SIV. Contd.

2004, Kerr et al. (30)	Systematic review (phase I) RCTs Other (phase II)	18	–	–	6 level I 4 level III and IV 8 level V	PEDro, CINAHL, MEDLINE Amed using "electrical stimulation and CP"	–	–	–	AACPDM levels of evidence	–	–	–	II (8)
------------------------	---	----	---	---	--	---	---	---	---	---------------------------	---	---	---	--------

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; RCT: randomized controlled trial; SD: standard deviation; GMFCS: Gross Motor Function Classification System; PT: physical therapy; NDT: neurodevelopmental treatment; NMES: neuromuscular electrical stimulation; HZ: Hertz; GMFM: Gross Motor Function Measure; BTX-A: botulinum toxin type A; 3DGA: 3-dimensional gait analysis; EMG: electromyography; MAS: Modified Ashworth Scale; ROM: range of motion; Glut Max: m gluteus maximus; aROM: active range of motion; pROM: passive range of motion; MVC: maximum voluntary contraction; triceps s. mm. triceps surae; gastroc: m. gastrocnemius; MRI: magnetic resonance imaging; Unilat: unilateral; CMAP: compound muscle action potential; AACPDm: American Academy of Cerebral Palsy and Developmental Medicine.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SV. Overview of studies using isotonic strength training: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results			Level of evidence (conduct)
		n (exp)	n (contr)								Exp	Contr	Exp vs cont	
1995, Damiano et al. (32)	Pre-postdesign Prospective Case series	14	–	6–14 years Mean 9.1 years (SD 2.5)	Spastic diplegia Ambulant Knee flexion contracture	Training Qcps Ankle load 65% f 1bRM, 4×5 repetitions Isotonic, concentric and eccentric	6	–	3	MVC quadriceps (handheld dynamometer) Crouch gait (3DGA) Stride length (3DGA)	↑ ↓ ↑		I A A	IV (5/7)
1995, Damiano et al. (33)	Prospective Non-randomized CT	14	25 (non-CP)	6–14 years Mean 9.1 years (SD 2.5)	Exp: spastic diplegia Contr: non-CP	Exp: 65% bmax Qcps Contr (NL): 65% max Qcps	6	–	3	Strength m.Qcps (handheld dynamometer)	↑		I A	IV (5/7)
1998, Damiano & Abel (34)	Pre-postdesign Prospective Case series	11	–	6–12 years Mean 8.81 years (SD 2.32)	Diplegia (6) Hemiplegia (5) Limited community ambulators	Training the weakest lower limb muscles Velcro-attached free-weights, 65% of max isometric strength 4×5 repetitions	6	–	3	MVC (isometric, handheld dynamometer), 8 muscles Gross motor function (GMFM) Gait (3DGA) Energy expenditure (heart telemetry)	↑ ↑ =		I A I	IV (5/7)
2004, Johnson et al. (35)	Case series AB design	5	–	3 years 10 months–9 years 11 months Mean 6.06 years	Diplegia (1) Hemiplegia (3) Ataxia (2)	3 components, 2×/day, concentric and eccentric Trampoline jumping, slope walking, toe raises, sit-to-stand, stair-climbing	3	3	14	Gait (video and footprint analysis) ROM ankle during midstance (goniometer and markers) Strength plantar flexors (sphygmometer)	= = =		I A I	IV (2/7)
2004, Eagleton et al. (36)	Pre-postdesign Prospective Case series	7	–	12–20 years	Not reported Independently ambulant	Training programme (school gym of local fitness centre) Free weights and Thera-Band exercises for trunk, hip and knee and ankle flexors and extensors, hip abductors 40–60 min, 8–10 repetitions at 80% 1 RM	6	–	3	Gait velocity, cadence and step length (10-m walk test) 3 min walk test Energy expenditure index (heart rate pre-and post walking test)	↑ ↑ ↓		A A I	IV (2/7)
2004, Dodd et al. (37)	RCT Smaller RCT	10	7	8–16 years Mean 12.1 years (SD 2.5)	Spastic diplegia	Exp: home-based, hip extensor, ankle plantar flexor, knee extensor (heel rises, half squats, step-ups) Contr: normal daily activities	6	12	3	Self-concept Perception of scholastic competence Perception of social acceptance Perception of athletic competence		= ↓ ↓ ↓	I I I I	II (5/7)

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SV. Contd.

2005, Morton et al. (38)	Repeated measures Prospective Single case AB	8	–	6 years 10 months–11 years 2 months Mean 8 years 5 months	Hypertonia GMFCS III	Progressive strengthening programme, hamstrings and Qcps Free-weight (65% of max isometric strength)	6	4	3	Muscle strength Qcps and hamstrings (hand-held dynamometer) Resistance to passive stretch (myometer) Motor development (GMFM) 10-m timed walking test and walking speed	↑ ↓ ↑	I I A	IV (5/7)
2006, Unger et al. (39)	RCT Smaller RCT	21	10	13–18 years Mean exp 15.9 years Mean contr 16.28 years	Hemiplegia (16) Diplegia (15) Independently ambulant	Exp: circuit training, free weights, 1–3×/week, 40–60 min Individually designed programmes, 8–12 exercises Contr: no additional intervention	8	–	2	Measure of crouch (3DGA) Economy of movement (3DGA) Perception of functional competence (Self Perception Questionnaire) Perception of body image	↑ ↑ =	I/A I I	II (5/7)
2008, Eek et al. (40)	Pre-postdesign No control Case series	16	–	Mean 12 years 6 months Range 9 years 4 months–15 years 4 months	GMFCS I–II Spastic diplegia	Free weights, rubber bands, body weight, 3×10 repetitions (easy, medium and heavy)	8	–	3	Muscle strength hip, knee and ankle (handheld dynamometer) Gross motor function (GMFM) ROM hip, knee, ankle (goniometer) Gait kinematics and kinetics (3DGA) Spasticity hip adductors, hamstrings, plantar fl and rectus femoris (MAS)	↑ ↑ ↑ ↑ =	I A I A I	IV (4/7)
2008, Lee et al. (41)	RCT Smaller RCT	9	8	Exp: mean 6.3 years, (SD 2.1) Contr: mean 6.3 years, (SD 2.9)	Spastic diplegia (9) Spastic hemiplegia GMFCS II–III	Exp: strengthening programme, 5 60 min (warm up, functional strengthening exercises, isotonic exercises using weight cuffs, 2–10 repetitions) Contr: usual care (NDT, ROM exercises, gait)	5	6	3	Muscle tone hip and knee (MAS) Gross motor function (GMFM) Strength hip, knee, ankle (MMT) Gait (3DGA) Lateral step-up, squat to stand	= ↑ ↑ ↑ ↑	I A I I/A A	II (4/7)



Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SV. Contd.

2009, McNee et al. (42)	Pre- postdesign Case series	13	-	6 years 11 months-16 years 11 months Mean 10 years 11 months (SD 3)	8 diplegia (8) 5 hemiplegia (5) GMFCS I-III	Plantar flexion strengthening (Thera-Band and heel rises)	10	13	4	Muscle volume of m. gastrocnemius med & lat (3D US) Gait (3DGA) Gross motor function (GFAQ, FMS, TUG) Unilateral heel rises pROM ankle (goniometer)	↑  = = ↑ =	I  I/A A  I I	IV (4/7)
-------------------------------	-----------------------------------	----	---	--	--	--	----	----	---	--	---------------------------	---------------------------------	----------

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; RCT: randomized controlled trial; SD: standard deviation; GMFCS: Gross Motor Function Classification System; Qcqs: m. quadriceps femoris; RM: repetition maximum; MVC: maximum voluntary contraction; 3DGA: 3-dimensional gait analysis; GMFM: Gross Motor Function Measure; ROM: range of motion; MAS: Modified Ashworth Scale; MMT: manual muscle testing, GFAQ: Gillette Functional Assessment Questionnaire; FMS: Functional Mobility Scale; MMT: Manual Muscle Testing; TUG: Timed Up and Go; pROM: passive range of motion; NDT: neurodevelopmental treatment.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVI. Overview of studies using functional, isokinetic, isometric and mixed strength training: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design Type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results			
		n (exp)	n (contr)								Exp	Contr	Exp vs cont	ICF
<i>Functional strength training</i>														
2003, Blundell et al. (43)	Prospective Repeated measures Single-subject ABA	8 (pilot)	–	Mean 6.3 years Range 4–8 years (SD 1.3)	diplegia (7) quadriplegia (1) ambulatory	Phase 1: 2 weeks follow-up Phase 2: 1-h circuit training (functional strength : treadmill, steps, sit to stand, leg press) Phase 3: 8 weeks follow-up	4	8	2	Strength hip, knee and ankle flexors and extensors (dynamometer) Motor Assessment Scale: sit-to- stand, lateral step-up Minimum Chair Height Test Walking speed (2-min walk test) Walking speed (timed 10-metre test)	↑  ↑ = ↑		I	IV (9/14)
2003, Dodd et al. (44)	RCT Smaller RCT	11	10	Mean 13 years 1 months (SD 3 years 1 months) Range 8–18 years	Spastic diplegia GMFCS I–III	Home-based training Exp: LL training : heel squats, heel raises and step-ups (3 sets of 8–12 repetitions, 20–30 min) Contr: usual care	6	12	2	Strength ankle plantar flexors, knee+hip extensors, (hand-held dynamometer) Gross motor function (GMFM) Timed-stair test Self-selected walking speed (10-m walking test)		↑ = = =	I	II (7/7)
2003, McBurney et al (45)	Prospective No control Case series	11	–	Mean 12 years 9 months (SD 2 years 10 months) Range 8–18 years	Spastic diplegia GMFCS I–III	Home-based training, 8–10 repetitions each Heel squat, heel raise and step-up (plantar flexors, knee extensors, hip extensors)	6	–	3	Perception of body image Perception of functional performance Perception of social participation	↑ ↑ ↑		I	IV (3/7)
2007, Liao et al. (46)	RCT Smaller RCT	10	10	Range 5–12 years Exp: mean 85.6 months, (SD 20.8) Contr: mean 91.3 months, (SD 17.5 months)	Spastic diplegia GMFCS I and II	Exp: regular PT+sit-to-stand exercises Contr: regular PT only	6	–	3	Gross motor function (GMFM) Gait speed (timed 10-m walking test) Isometric strenght Qcps (Nicholas Manual Muscle tester) Sit to stand Physiologic Cost Index (heart rate walking – rest/walking speed)		↑ = = ↑ ↑	I A	II (6/7)

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

<i>Isokinetic strength training</i>													
1995, Mac-Phail et al. (47)	Pre-postdesign Prospective Case series	17	-	12-20 years	Quadriplegia (1) Diplegia (7) Hemiplegia (9) Ambulant without aids	Min 45 min 3 submaximal warm-up efforts, 15 concentric and 15 eccentric MVC of knee extensors and flexors	8	13	3	Peak torque knee flexors and extensors (dynamometer) Spasticity (MAS+ankle clonus) Gross motor function (GMFM) Walking efficiency (Energy Expenditure Index, HR)	↑ = ↑ =	I A	IV (2/7)
2006, Engsborg et al. (48)	RCT Smaller RCT	12	-	Mean 9.7 (SD 3.3)	Spastic diplegia GMFCS I-III	Exp 1 (n=3): dorsiflexor group Exp 2 (n=3): plantar flexor group Exp 3 (n=3): dorsi+plantarflexor group Exp 4 (n=3): control group	12	13	3	Gross motor function (GMAE-GMFM) pROM ankle (goniometer) Strength ankle plantar and dorsiflexors (KinComdynamometer) Gait kinematics and gait speed (3DGA) Spasticity (KinCom dynamometer) Quality of life parents - children (Peds QoL)	=, ↑ = = ↑ = ↑, = ↓ = ↑, = ↓	I A P A E/QoL	II (4/7)
<i>Isometric strength training</i>													
2007, Stackhouse et al. (27)	RCT Smaller RCT	6	5	8-12 years Exp: mean 10 years 7 months Contr: mean 10 years 5 months	Spastic diplegia GMFCS II-III	Contr: NMES percut, pulse duration 5-200 μs, amplitude 25 mA, pulse freq 50 pps, 15 min Exp: volitional max effort contractions, 15 MVIC Qcps and triceps s	12	-	3	MVIC Qcps (dynamometer) MVIC m. triceps surae (dynamometer) Walking speed (3DGA) Qcps cross-stional area (MRI) Triceps S cross-stional area (MRI)	↑ ↑ ↑ = = ↑ = ↑ = = = ↑ = = =	I A	II (4/7)
<i>Mixed strength training</i>													
2001, Fowler et al. (49)	Pre-postdesign Prospective Non-randomized CT	24	12	7-17 years (non-CP) Mean 11.4 (SD 3)	Exp: spastic diplegia Contr: typically developing	Isometric Qcps (kinCOM) Isotonic Qcps (cuff weights) Isokinetic Qcps (60°/s) Max 25 repetitions, 1 session	0.1	-	-	Stretch reflexes pendulum test (spasticity KinCom; EMG+goniometer)	=	I	IV (4/7)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; E: environmental factors; RCT: randomized controlled trial; SD: standard deviation; LL: lower limb; PT: physical therapy; percut: percutaneous; MVC: maximum voluntary contraction; GMFCS: Gross Motor Function Classification System; Qcps: m. quadriceps femoris; triceps s: m. triceps surae; MVIC: maximum voluntary isometric contraction, HR: heart rate; GMFM: Gross Motor Function Measure; GMAE: Gross Motor Activity Estimator; MRI: magnetic resonance imaging; HR: heart rate; QoL: Quality of Life; 3DGA: 3-dimensional gait analysis; pps: pulses per second; kinCOM: refers to the type of an isokinetic dynamometer.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVII. Overview of the systematic reviews evaluating strength training

Study	Design type	Subjects		Method					Results			Level of evidence (conduct)		
		n	Age	Type	Intervention	Duration (weeks)	Follow-up (weeks)	Freq (×/week)	Evaluation	Exp	Contr		Int vs Contr	ICF
1997, Darrah et al. (50)	Systematic review	7 studies	–	–	MEDLINE, CINAHL, Eric, PsycINFO, Sport DISCUS Key words: cerebral palsy, exercise, strength and physical training 1966–1997	–	–	–	Sackets level of evidence				–	II (7)
1998, Haney et al. (51)	Systematic review	8 studies	–	–	Search strategy not reported	–	–	–	–				–	II (1)
2002, Dodd et al. (52)	Systematic review	23 studies	–	–	MEDLINE, PubMed, Embase, CINAHL, Sports Discus DARE, PsycINFO, ERIC, AusportMed, AMI, Cochrane, PEDro; 1966–2000 Key words: exercise, strength and physical training	–	–	–	PEDro scale				–	II (8)
2008, Verschuren et al. (53)	Systematic review	20 studies	–	–	MEDLINE, PubMed, Embase, CINAHL, Sports Discus, Cochrane, PEDro, until Sept 2006 Key words: CP, exercise, strength, working capacity, (an)aerobic power, endurance, cardiorespiratory physical training	–	–	–	PEDro Scale Outcome on ICF				–	II (8)
2008, Mockford et al. (54)	Systematic review	13 articles	–	–	MEDLINE, AMED, CINAHL, Cochrane Library, Embase, PEDro, PsycINFO, SPORTDiscus, until March 2007 Key words: CP, strength exercise, weight training and lifting, resisted exercise, resistance exercise, resisted training, resistance training	–	–	–	Amsterdam–maastricht List				–	II (8)
2009, Scianni et al. (55)	Systematic review Meta-analysis	6 RCTs	–	–	CINAHL, MEDLINE, Embase and PEDro No language restrictions, RCTs only Children with spastic CP up to 20 years	–	–	–	PEDro Meta-analysis ICF				–	I (8)

n: number; Freq: frequency; Int: intervention group or intervention period; ICF: International Classification of Functioning, Disability and Health; RCT: randomized controlled trial; Exp: experimental group of experimental period; Contr: control group or control period; Int: intervention group or intervention period.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVIII. Overview of studies using endurance and physical fitness training: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results				Level of evidence (conduct)
		n (exp)	n (contr)								Exp	Contr	Exp vs contr	ICF	
1998, van den Berg-Emons et al. (56)	RCT Smaller RCT	10	10	Mean 9.2 years (SD 1.4)	Spastic CP Diplegia (16) Tetraplegic (4) Ambulant and non-ambulant	Sports programme Group 1: 2×/week gymnastic lessons+4×/week physical training+usual PT Group 2: 2×/week gymnastic lessons+usual PT Physical training=wheelchair driving, cycling, running, swimming, flying-saucer exercises, mat exercises	39	–	2	Physical Activity Ratio (total energy expenditure/sleeping meth rate) Fat mass (anthropometry) Peak aerobic power (ergometer) Anaerobic power (ergometer) Isokinetic muscle strength (Cybex II)	↑	=	=	A	II (3/7)
1999, Darrah et al. (57)	Prospective Case series	23	–	Mean 14.2 years	Hemiplegia (13) Diplegia (5) Quadriplegia (2) Ataxia (2) Dystonia (1) Ambulant without aids	Warm-up (10 min), aerobic exercise (10–30 min), strength training (30 min), stretching and cooling-down (20 min) Group training	10	10	3	Energy Expenditure Index (EEI) and heart rate Strength of shoulders flexors, knee extensors, hip extensors and abductors (handheld dynamometer) Flexibility (sit-and-reach test, behind the back reach) Self Perception Profile fo Adolescents and Children Oxygen Uptake (respirometer/gasometer)	=			I	IV (3/7)
2002, Shinohara et al (58)	Prospective intervention Control Non-randomized CT	6	5	Exp: Mean 14.6 years, (SD 0.9) Range 13.3–15.8 Contr: Mean 14.2 years, (SD 10.7) Range 11.8–16.3	Ambulant Non-ambulant	Exp: leg exercises, 20 min at AT point (Varying duration and frequency: 8–20.6 weeks, 1.1–2.3×/week) Contr: arm cranking ergometer, 20 min at AT point (Varying duration and frequency: 5–19.9 weeks at 1–2.3 ×/week Work rate 7 or 10 W per min	13	–	1.8		↑	=		I	IV (3/7)

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVIII. *Contd.*

2005, Schlough et al. (59)	ABAB Single case	3	–	17–20 years	Spastic CP Hemiplegia (1) Diplegia (2) GMFCS I and III	A1: no intervention B1: initial intervention: treadmill, stepper, elliptical machine A2: no intervention B2: additional 15 weeks, treadmill, stepper, elliptical machine	6 B1 6 weeks B2 7 weeks	2 A1 2 weeks A2 2 weeks	3	Energy Expenditure Index (EEI) Muscle strength Qcps, hamstrings, ankle plantar and dorsiflexors (handheld dynamometer) Gross motor function (GMFM) Self-Perception Profile for College Students (SPCS) Rate of Perceived Exertion (RPE)	Not stats		I	IV (9/14)	
2007, Verschuren et al. (60)	RCT Multicentre Smaller RCT	32	33	7–18 years Exp: Mean 11.6 years, (SD 2.5) Contr 2: mean 12.7 years, (SD 2.7)	GMFCS I–II Unilateral (45) Bilateral (23)	Exp: usual care+45 min circuit Contr: usual care Circuit training: 5 min warm-up, 25–35 min functional aerobic exercises, anaerobic exercises and muscle strengthening in circuit, 5 min cool-down	35	17.3	2	Anaerobic capacity (muscle power sprint test) Aerobic capacity (10-min shuttle run test) Strength lower extremities (30 s RM) Agility (10×5-m sprint test) Gross motor function (GMFM) Participation in daily activities (HRQoL, CAPE)	↑		I	II (5/7)	
2007, Williams & Pountnet (61)	Prospective Single- subject ABA	11	–	11–15 years Mean 12 years 7 months SD 1 years 4 months	GMFCS IV–V Spastic (8) Dyskinetic (3) Diplegia (1) Quadriplegia (7)	Phase A: baseline, no intervention Phase B: training (75% of max endurance, 100% for speed/power) Phase C: follow-up, no intervention	6	6	3	Gross motor function (GMFM) Cycling ability (Pedalling resistance, overload)	↑	=	A	IV (10/14)	
2007, Uninithan et al. (62)	RCT Smaller RCT	7	6	Exp mean: 15.9 years Range 14–18 years Contr mean; 2=15.7 years Range 14–17 years	Spastic diplegia GMFCS II and III	Exp: 70 min/session, aerobic interval training and strength (handweights, 20 repetitions (UL) and 4×10 (LL)+usual PT (2×/week NDT) Contr: usual PT NDT 2×/week, no additional training	12	–	3	Gross motor function (GMFM) VO <sub>2</sub> (open circuit spirometer) %VO <sub>2</sub> max (open circuit spirometer) VE peak	↑	=	↑	A	II (4/7)

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVIII. *Contd.*

2009, Gorter et al. (63)	Repeated measures Single-subject AB design	13	–	8–13 years	GMFCS I and II	Functional circuit training addressing aerobic endurance, walking distance, walking velocity and ambulation A circuit with 4 stations 30 min, 60–70% H <sub>r</sub> max	9	11	2	Max aerobic capacity (Bruce Test) Walking distance and velocity (6-min run test) Functional mobility (Timed Up and Down Stairs Test) Ambulation Questionnaire (MoVra)	↑ ↑ ↑ ↑	A A A A	IV (4/14)
2008, Rogers et al. (64)	Systematic review	13 studies	–	–	–	MEDLINE, Embase, CINAHL, Pascal, Cochrane Library, CSA Neuroscience Abstracts, PEDro and Sports Discus 1960–2006 Key words: cerebral palsy, athetoid, ataxic, spastic diplegia, hemiplegia, quadriplegia, aerobic exercise, training, physical activity, aquatic/pool/water therapy, exercise training, continuous exercise	–	–	–	AACPDM guidelines		–	II (8)
2009, Verschuren et al. (65)	Systematic review	20 studies	–	–	–	MEDLINE, PubMed, Embase, CINAHL, Sports Discus, Cochrane, PEDro Until September 2006 Key words: cerebral palsy, exercise, strength, working capacity, aerobic/anaerobic power, endurance, cardiorespiratory physical training	–	–	–	AACPDM guidelines		–	II (8)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; UL: upper limb; RCT: randomized controlled trial; SD: standard deviation; PT: physical therapy; AT point: anaerobic threshold point; W: watt; Qcps: m. quadriceps femoris; RM: repetition maximum; GMFM: Gross Motor Function Measure; HRQoL: health-related quality of life; CAPE: Children's Assessment of Participation and Enjoyment; MoVra: Mobiliteitsvragenlijst/mobility questionnaire; AACPD: American Academy of Cerebral Palsy and Developmental Medicine; GMFCS: Gross Motor Function Classification System.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SIX. Overview of studies using weight-bearing: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results			Level of evidence (conduct)		
		n (exp)	n (contr)								Exp	Contr	Exp vs cont		ICF	
1999, Chad et al. (66)	RCT Smaller RCT	9	9	Exp: mean 9 years, (SD 2.9) Contr: mean 9 years, (SD 2.7)	Dependent and independent walkers	Exp: weight-bearing physical activity, 2×/week (2 months) and 3×/week (6 weeks), 60 min (20 min UL, 20 min LL, 20 min trunk, facilitation of normal movement with weight-bearing) Contr: usual lifestyle habits	14	–	2.5	Bone mineral content proximal femur and femoral neck % Bone mineral content proximal femur and femoral neck (Dual-energy X-ray absorptiometry)			↑	I	II (2/7)	
2000, Katz et al. (67)	Prospective intervention Case series	36	–	Mean 5 years 4–7 years	Diplegia (14) Hemiplegia (15) Ambulatory	Achilles tendon lengthening surgery+2 weeks casting and early weight-bearing (after 2 days) and gait training	2	260	Not reported	pROM ankle (goniometer) Visual gait analysis (heel/toe contact)	No stats				I I/A	IV (1/7)
2002, Gudjonsdottir et al. (68)	Prospective intervention Smaller RCT	2	2	4 years 5 months–5 years 11 months	Non-ambulant	Phase 1 (8 weeks): group 1 dynamic standing, group 2 static stander (5×/week, 30 min) Phase 2 (3 sessions): all children standing in the different standing frames	8	–	5	ROM hip and knee ext, ankle dorsiflex (goniometer) BMC femoral neck, great trochanter, intertrochanteric (dual energy X-ray absorptiometry)	No stats				I	II (3/7)
2004, Caulton et al. (69)	RCT Smaller RCT	13	13	4.3–10.8 years	Non-ambulant	Exp: 50% longer standing Contr: normal duration of standing varying from 14 min to 365 min standing/week	39	–	7	Behavioral characteristics (CRIB) Vertebral tibial volumetric trabecular bone density (vTBMD) (quantitative computed tomography) Proximal tibial volumetric trabecular bone density (vTBMD) (quantitative computed tomography)			↑	I	II (5/7)	
													=	I		



Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SVIX. *Contd.*

2009, Gibson et al. (70)	Prospective intervention Single-subject ABAB design	5	–	5–9 years Mean 7 years 2 months SD 1 years 4 months	Non-ambulant	Phase A: standing in a standing frame, 1 h/day Phase B: no intervention ABAB design	6	–	5	Popliteal angle (goniometer and angle finder) ADL (feedback form)	↑ ↓ ↑ =	↓ =	↑ =	I A	IV (9/14)
2009, Eisenberg et al. (71)	Prospective intervention Controlled; non-randomized	11	11	Exp: mean 6.2 years, (SD 2.1) Contr: mean 6.7 years, (SD 1.6)	Spastic quadriplegia GMFCS IV–V	Exp: Heart Walker Contr: passive standing programme	26	–	7	Bowel activity (diary) Functional performance (PEDI) Bone mineral density (quantitative ultrasound) Walking speed, endurance (2-min walking test) PEDro scale	↑ ↑ ↑ ↑	= ↑ =	↑ =	I A/P I A	III (4/7)
2007, Pin et al. (72)	Systematic review	–	–	–	–	MEDLINE, CINAHL, PsycINFO, Embase, full Cochrane library, PEDro Start – 2006 Key words: child, cerebral palsy, bone density, hip dysplasia, contracture, range of motion, stretching, muscle spasticity, bowel and urinary function, morale, communication, hand function, feeding	–	–	–						II (7)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; RCT: randomized controlled trial; SD: standard deviation; PT: physical therapy; pROM: passive range of motion; BMC: bone mineral content; ADL: activities of daily living; CRIB: Carolina Record of Individual Behavior; PEDI: Pediatric Evaluation of Disability Inventory; GMFCS: Gross Motor Function Classification System; No stats: no statistical analysis..

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SX. Overview of studies using balance training: subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects		Age	Type	Method Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Results				
		n (exp)	n (contr)								Exp	Contr	Exp vs Contr	ICF	Level of evidence (conduct)
1995, Myhr et al (73)	Retrospective cohort	10	–	2.1–5.8 years Mean 3.6 years	Mild	5 y functional sitting position (pelvis forward, upper body anterior to the fulcrum, hip belt and abduction orthosis)	260			Not specified Sitting position (Sitting Assessment Scale)	↑			I/A	IV (3/7)
	Case series				Severe Spastic diplegia						Head/trunk control	↑			
2003, Shumway–Cook et al. (74)	Prospective intervention	6	–	9 years 2 months–12 years 11 months Mean 9 years 2 months (SD 2)	Hemiplegia (2) Diplegia (4) GMFCS I and II	Phase A: usual therapy only Phase B: balance training on moving platform (100 perturb/day for 5 days)+usual PT 30 min–1 h/week ABA design	0.8	1	7	Area and time to stabilization from CoP (moving forceplate) Gross motor function (GMFM)			↓	I	III (9/14)
	Single-subject ABA design												=	A	
2005, Ledebt et al. (75)	RCT	5	5	5–11 years	Hemiplegia	Group 1: balance training with visual feedback Group 2: control group	6	4	3	CoP displacement standing	↓	=	=	I/A	II (4/7)
	Smaller RCT									CoP displacement during dynamic standing (Force-plate data)	↓	=	↓	I/A	
										Mean step length asymmetry	↓	=	↓	A	
2005, Woollacott (76)	Prospective intervention	6	–	Mean 9 years 4 months	Hemiplegia (2) Diplegia (4) GMFCS I and II	5 days of intensive reactive balance training (100 perturbations/day on a moveable platform)	0.8	4.3	7	Muscle co-contractions (EMG):					IV (4/7)
	Case series									Timing of activation of muscle contraction	↓			I	
										Distal-proximal muscle sequence	↑			I/A	
										Agonist	↑			I	
2008, Bar-Haim et al. (77)	RCT	10	10	8.9–12.9 years Mean 9.2	GMFCS II–IV	Contr: structured intensive treatment Exp: structured intensive treatment+random perturbation 1 month, daily treatment of 1.5 h, 20 sessions Physio: stretching, functional weight-bearing, walking activities Random perturbation: engine-induced passive cycling, 10 min	4.3		7	Gross motor function (GMFM)	↑	=	=	A	II (4/7)
	Smaller RCT									Mechanical efficiency during stair climbing (rate oxygen consumption)	=	↑	↑	I	

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

2005, Harris & Roxborough (78)	Systematic review Systematic review	12	-	-	-	Search on MEDLINE, CINAHL, Embase, PsycINFO, SPORTDiscus, Cochrane Database of Systematic Reviews, Cochrane Controlled Trial Register, PEDro, DARE, Dissertation Abstracts 1990-2004 Cerebral palsy, balance, posture, postural control	-	AACPDM guidelines	II (8)
---	--	----	---	---	---	--	---	-------------------	--------

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; RCT: randomized controlled trial; SD: standard deviation; PT: physical therapy; pROM: passive range of motion; CoP: centre of pressure; GMFM: Gross Motor Function Measure; EMG: electromyography; AACPDM: American Academy of Cerebral Palsy and Developmental Medicine; GMFCS: Gross Motor Function Classification System.

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SXI. Overview of studies using treadmill training – subjects, interventions, evaluation, results and level of evidence with conduct scores

Study	Design type	Subjects			Method						Results				
		n (exp)	n (contr)	Age	Type	Intervention	Duration of intervention (weeks)	Duration of follow-up (weeks)	Freq of intervention (×/week)	Evaluation	Exp	Contr	Exp vs cont	ICF	Level of evidence (conduct)
1997, Richards et al. (79)	Prospective intervention Case series	4	–	1.7–2.3 years	Non-ambulant	Treadmill training+conventional NDT-based PT Treadmill on low speed (7 cm/s), progressive weight-bearing	17.3	–	4	Gross motor function (GMFM) Gait (videographic test +3DGA) Supported Walker Ambulation Performance Scale	=			A	IV (3/7)
2000, Schindl et al. (80)	Prospective intervention Single-subject AB	10	–	6–18 years Mean 11.5 years	6 non-ambulatory 4 req cont phys assistance	Phase B: BWSTT , 25 min/ session Body weight support at start: X= 14% (0–40%)+ usual PT Mean treadmill speed 0.23 m/s (start of the study) to 0.40 m/s (end of the study ) Phase A: usual PT only (30 min, 2–3 sessions per week)	13	–	3	Gross motor function (GMFM) Functional ambulation category	↑	=		A	V (8/14)
2007, Cherng et al. (81)	ABA or AAB Single-subject Alternating treatment	4	4	3.5–6.3 years Mean 4 years	GMFCS I–III Spastic diplegia	Exp: ABA Contr: AAB A=regular physio, NDT, 30 min/ session B=BWSTT, 20 min/ session+regular physio	12	6	2.5	Gross motor function (GMFM) Time and distance parameters (GaitRite) muscle tone (MAS) Selective motor control (SMC)	↑	=		A	II (9/14)
2007, Philips et al. (82)	Prospective intervention Case series	6	–	6–14 years Mean 10 years 5 months	Hemiplegia (4) Diplegia (2) GMFCS I	2×/day BWSTT Body support decreased from 30% initially to 0% Treadmill speeds ranged from 2.4 to 3.1 km/h initially and increased to 3.7–5.0 km/h with training.	2	–	14	fMRI (3 tasks): (1) active ankle dorsiflexion of the involved ankle; (2) finger tapping of the uninvolved hand; and (3) active ankle dorsiflexion of the involved ankle Walking speeds Distance walked for 6 min	=			I	IV (3/7)
											↑			A	
											=			A	

Supplementary material to article by I. Franki et al. "The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework"

Table SXI. *Contd.*

2007, Dodd & Foley (83)	Prospective Matched pairs Non- randomized controlled trial	7	7	5–14 years Mean 8 years 10 months (SD 2 years 6 months)	GMFCS III–IV Athetoid quadriplegia (6) Spastic quadriplegia (6) Spastic diplegia (2)	Exp: BWSTT, comfort speed (0.40 km/h up to 0.60 km/h) Until child stopped or was tired (med 12 min (start) to 21 min (end) Contr: usual PT (content not reported)	6	–	2	10-min walk test Self-selected walking speed in 10 min	= ↑	A A	II (4/7)
2007, Begnoche & Pitetti (84)	Prospective intervention Case series	5	–	2.3–9.7 years	Quadriplegia (1) Diplegia (4) GMFCS I–IV	2 h/session treadmill+NDT 15–35 min/session partial body weight treadmill training	4	–	3.5	Gross motor function (GMFM) Functional performance (PEDI-FS) Gait (pedography) Walking speed (timed 10-metre walk test)	= = ↑ = ↑	A A/P I/A A	IV (3/7)
2007, Provost et al. (85)	Prospective intervention Case series	6	–	6–14 years	Diplegia (4) Hemiplegia (4) Ambulatory GMFCS I	Body weight supported treadmill training 2×/day 30 min	2	–	14	Gross motor function (GMFM) Energy expenditure 6-min walking test Ten-Meter Walking Velocity Single Leg Balance Test	= ↓ ↑ ↑ = ↑	A I A A A	IV (4/7)
2009, Dieruf et al. (86)	Prospective intervention No control Case series	6	–	6–14 years	GMFCS I Diplegia (2) Hemiplegia (4)	2×30 min/day BWSTT (30 min: 10 min walking interspersed with 5 min rest)	2	–	14	Quality of life (Ped QoL Inventory ) fatigue (PedsQL multidisciplinary Fatigue Scale)	= = = = = ↑	QoL QoL	IV (3/7)
2009, Hodapp et al. (87)	Prospective intervention Case series	7	–	5–15 years Mean 9.7 years	GMFCS I–III	treadmill training, without body weight support 1.90–3.10 km/h	1.5	–	7	Soleus H reflex Walking speed (ground and treadmill walking velocity)	↓ ↑	I A	IV (4/7)
2009, Mattern-Baxter et al. (88)	Prospective intervention Case series	6	–	2.5–3.9 years	GMFCS I–IV Spastic diplegia (3) Spastic quadriplegia (1) Hypotonia (1) Dystonia (1)	2 individualized treadmill walks 1 h, gait speed as fast as possible	4	4.3	3	Gross motor function (GMFM) Functional performance (PEDI) Walking speed (6 minute walk test) Walking speed (10-metre walk test)	↑ ↑ ↑ ↑	A A/P A A	IV (5/7)
2009, Willoughy et al. (89)	Systematic review	5	–	–	–	CINAHL, Cochrane, PEDro, ERIC, PsycINFO, AMED, PubMed, Ausport Medical and Sports Discus Until July 2008 Key words: cerebral palsy, child, treadmill training	–	–	–	Effect sizes			II (9)

Supplementary material to article by I. Franki et al. “The evidence-base for basic physical therapy techniques targeting lower limb function in children with cerebral palsy: a systematic review using the ICF as a conceptual framework”

Table SXX. *Contd.*

2009, Mattern-Baxter et al. (90)	Systematic review	10 studies	-	-	-	Academic Search Complete, Blackwell Synergy, Cochrane Library, Google Scholar, Health Source, Nursing Academic, PubMed, Science Direct, SCOPUS and SPORTDiscus Key words: adolescent, child, gait, physical endurance, fitness, spastic CP, treadmill training and walking; 1997–2008	-	-	-	Sackett’s levels of evidence	II (6)
2009, Mutlu et al. (91)	Systematic review	-	-	-	-	MEDLINE, PubMed, Google, Embase, Ovid MEDLINE, Galter Health Sciences Library, PEDro Cochrane, CINAHL, APTA 1950–2007 Key words: CP, treadmill training, PBWSTT, locomotor therapy, gait, walking, physial therapy methods	-	-	-	AACPDM guidelines Developmental Medicine and the Critical Review Form – Quantitative Studies Methodological Quality	II (8)

Exp: experimental group or experimental period; Contr: control group or control period; Freq: frequency; Int: intervention group or intervention period; =: results were not significantly different between the control and experimental group or period; ↑: results were significantly higher in the experimental group or during the experimental period; ↓: results were significantly lower in the experimental group or during the experimental period; ICF: International Classification of Functioning, Disability and Health; I: impairment level; A: activity level; P: participation level; fMRI: functional magnetic resonance imaging; RCT: randomized controlled trial; SD: standard deviation; PT: physical therapy; NDT: neurodevelopmental treatment; 3DGA: 3-dimensional gait analysis; GMFCS: Gross Motor Function Classification System; GMFM: Gross Motor Function Measure; BWSTT: body weight supported treadmill training; QoL: Quality of Life; PEDI: Pediatric Evaluation of Disability Inventory; AACPDM: American Academy of Cerebral Palsy and Developmental Medicine; PBWSTT: partial body weight supported treadmill training.