National Institute for Health and Care Excellence

Final

Cerebral palsy in adults

[D2] Interventions that improve function and participation: physical function

NICE guideline NG119

Evidence reviews

January 2019

Final

These evidence reviews were developed by the National Guideline Alliance hosted by the Royal College of Obstetricians and Gynaecologists

Disclaimer

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or service users. The recommendations in this guideline are not mandatory and the guideline does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or their carer or guardian.

Local commissioners and/or providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

NICE guidelines cover health and care in England. Decisions on how they apply in other UK countries are made by ministers in the Welsh Government, Scottish Government, and Northern Ireland Executive. All NICE guidance is subject to regular review and may be updated or withdrawn.

ISBN: 978-1-4731-3223-8

Contents

Interventions that improve or maintain physical function and participation for adults over 25 with cerebral palsy.

Review question

D2 Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Introduction

Physical function and mobility can be reduced in adults with cerebral palsy due to a number of factors. These include musculo-skeletal weakness, disorders of tone, development of contracture and deformity as well as cognition and mood. Maintenance of strength and range of movement is therefore important. Current practice is based on physiotherapy such as stretching and occupational therapy, rehab engineering, and orthotics. This review question aims to look at the efficacy and cost of available interventions.

PICO Table

Please see Table 1 for a summary of the Population, Intervention, Comparison and Outcome (PICO) characteristics of this review.

Table 1: PICO table

Population	Adults aged 16 and over with cerebral palsy
Intervention	• Physical activity • Strengthening programmes or training • Orthotics • Task-oriented upper limb training • Orthopaedic surgery (including tendon lengthening and orthopaedic bony procedures in adulthood) • Powered mobility aids and wheelchairs
Comparison	• Each other • Usual care
Outcome	**Critical** • Participation (incorporating mobility) • Physical function • Health related quality of life & psychological wellbeing **Important** • Independence • Fatigue

	• Frequency of falls [in a subset] • Complications of treatment • Adherence

For full details see the review protocol in appendix A.

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guidelines: the manual 2014. Methods specific to this review question are described in the review protocol in appendix A.

Declaration of interests were recorded according to NICE's 2014 conflicts of interest policy from May 2016 until April 2018. From April 2018 onwards they were recorded according to NICE's 2018 conflicts of interest policy. Those interests declared until April 2018 were reclassified according to NICE's 2018 conflicts of interest policy (see Interests Register).

Clinical evidence

Included studies

Ten studies (number of participants, N=229) were included in the review, including 5 randomised controlled trials (Lorentzen 2017, Maeland 2009, Morgan 2015, Taylor 2013 and Teixeira-Machado 2017), 4 before-and-after studies (Ballaz 2011, Brown 2010, Houdek 2017 and Schroeder 2010) and 1 non-randomised controlled study (Hutzler 2013).

The comparisons included:

1. physical activity before versus after
2. physical activity versus standard care
3. strengthening or training programmes versus standard care
4. task-oriented upper limb training versus standard care
5. task-oriented upper limb training before versus after
6. orthopaedic surgery before versus after.

The clinical studies included in this evidence review are summarised in Table 2 and evidence from these is summarised in the clinical GRADE evidence profiles in Table 3 to Table 8.

See also the literature search strategy in appendix B study selection flow chart in appendix C, forest plots in appendix E and study evidence tables in appendix D.

Excluded studies

Studies excluded from this systematic review, with reasons for their exclusion, are provided in appendix K.

Summary of clinical studies included in the evidence review

Table 2 provides a brief summary of the included studies.

Table 2: Summary of included studies

Study	Design	Participants	Comparisons	Outcomes
Ballaz 2011	Observational before-and-after study	12 ambulatory adults with cerebral palsy, average age 17 years	Aquatic training programme,	• Participation • Physical function

Study	Design	Participants	Comparisons	Outcomes
		Canada	before versus after	
Brown 2010	Observational before-and-after study	12 adults with cerebral palsy, mean age, 33 years and 11 months ± 10 years United States	Home and Internet-based upper limb training, before versus after (N=12)	• Participation • Physical function
Houdek 2017	Observational before-and-after study	39 adults with cerebral palsy, mean age 49 years United States	Total hip arthroplasty surgery, before versus after (n=39)	• Participation • Physical function
Hutzler 2013	Non randomised controlled trial	17 adults with cerebral palsy Spain	Upper extremity strength training (n=10) versus usual care(n=7)	• Participation • Physical function • Independence
Lorentzen 2017	Randomised controlled trial	32 adults with cerebral palsy, mean age 38 years Denmark	Treadmill training (n=16) versus usual care(n=16)	• Participation
Maeland 2009	Randomised controlled trial	12 ambulatory adults with cerebral palsy, age range 27-65 yrs Norway	Progressive resistance exercise (n=6) versus usual care(n=6)	• Participation • Physical function
Morgan 2015	Randomised controlled trial	17 ambulatory adults with cerebral palsy, mean age 37 years, Australia	Balance training (n=9) versus seated attention(n=8)	• Participation • Health related quality of life • Fatigue • Frequency of falls • Treatment related complications • Compliance
Schroeder 2010	Randomised controlled trial	14 adults with cerebral palsy with severe functional limitation Germany	Hip arthroplasty, before versus after) (N=14)	• Participation • Independence
Taylor 2013	Randomised controlled trial	48 adults with cerebral palsy, mean age 18 years, 1 month Australia	Progressive resistance training(n=23) versus Usual care(n=25)	• Participation • Physical function
Teixeira-Machado 2017	Randomised controlled trial	26 young ambulatory adults with cerebral palsy Brazil	Dance therapy (n=13) versus Kinesiotherapy exercise(n=13)	• Physical function • Independence

N: number of participants in the study; n: number of participants in intervention/control groups; RCT: randomised controlled trial.

See appendix D for the full evidence tables.

Quality assessment of clinical outcomes included in the evidence review

The clinical evidence profiles for this review question are presented in Table 3 to Table 8.

Table 3: Summary clinical evidence profile: Comparison 1: Physical activity intervention, before versus after outcomes

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Before physical activity intervention	After physical activity intervention			
Participation: Walking efficiency(Gait energy expenditure index)[1] follow up: post-test at 10 weeks	The mean gait energy expenditure index before intervention was 1.77 (SD=1.3)	The mean gait energy expenditure index after intervention was 0.24 lower (1.3 lower to 0.82 higher)	-	10[5] (1 observational study)	Very low[2,3]
Physical function Gross Motor Function Measure (GMFM)[4] D & E follow up: post-test at 10 weeks	The mean gross motor function measure before intervention was 59 (SD=34.69)	The mean gross motor function measure after intervention was 5.00 lower (35.31 lower to 25.31 higher)	-	10[5] (1 observational study)	Very low[2,3]
Health related quality of life- not reported	-	-	-	-	-
Independence- not reported	-	-	-	-	-
Fatigue- not reported	-	-	-	-	-
Frequency of falls- not reported	-	-	-	-	-
Complications of treatment- not reported	-	-	-	-	-
Adherence- not reported	-	-	-	-	-

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; GMFM: gross motor function measure; SD: standard deviation.
1. Gait energy expenditure index: Lower values indicate better gait efficiency
2. Downgraded for serious risk of bias due to lack of blinding during assessment
3. Downgraded for serious imprecision as confidence interval includes one MID threshold
4. Higher GMFM scores indicate better motor function
5 10/12 participants completed the training intervention

Table 4: Summary clinical evidence profile: Comparison 2: Physical activity interventions versus standard care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Physical activity interventions			
Participation Change in maximal gait speed[1]	The mean change in maximal gait speed in the control group was -0.01 (SD=0.07)	The mean change in maximal gait speed in the intervention groups was 0.28 higher (0.23 to 0.33 higher)	-	32 (1 RCT)	Low[2,3]
Physical function ICF Total score	The mean physical function score in the control group was 69.55 (SD=4.39)	The mean physical function score in the intervention group was 29.65 lower (33.6 to 25.7 lower)	-	26 (1 RCT)	Low[3,4]
Health related quality of life- not reported	-	-	-	-	-
Independence	The mean independence score in the control group was 3.64 (SD=0.38)	The mean independence score in the intervention group was 1.74 higher (1.4 to 2.08 higher)	-	26 (1 RCT)	Low[3,4]

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Physical activity interventions			
Fatigue- not reported	-	-	-	-	-
Frequency of falls- not reported	-	-	-	-	-
Complications of treatment- not reported	-	-	-	-	-
Adherence- not reported	-	-	-	-	-

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; ICF: International Classification of Functioning; NGA: National Guideline Alliance; RCT: randomised controlled trial; SD: standard deviation
1. Higher mean change in maximal gait speed indicates better participation; change in maximal gait speed calculated by NGA team
2. Downgraded for serious risk of bias as information on withdrawal/dropouts is not reported for control group
3. Downgraded for serious imprecision as number of participants <400
4. Downgraded for serious risk of bias due to lack of blinding of assessors

Table 5: Summary clinical evidence profile: Comparison 3: Strengthening or training programmes versus standard care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Strengthening or training programmes			
Participation: Change from baseline in 2 min walk test[1] follow up: 24 weeks	The mean participation - change from baseline in 2 min walk test in the control groups was 5.5 (SD=37.33)	The mean participation - change from baseline in 2 min walk test in the intervention groups was 5.5 lower (34.74 lower to 23.74 higher)	-	15[12] (1 RCT)	Low[3]
Participation: Change from baseline in 6 min walk test[4] follow up: 8 to 24 weeks	The mean participation - change from baseline in 2 min walk test in the control groups was 11.3(SD=30.4)	The mean participation in the intervention groups was 0.07 higher (20.25 lower to 20.39 higher)	-	60 (2 RCTs)	Low[3]
Physical function: Change from baseline in Stair Climbing[5] (adapted from GMFM) follow up: 8 weeks	The mean change from baseline in stair climbing in the control groups was 1 (SD=12.72)	The mean change from baseline in stair climbing in the intervention group was 2.00 lower (23.27 lower to 19.27 higher)	-	12 (1 RCT)	Low[3]
Physical function: Change from baseline in GMFM 66[6] follow up: 24 weeks	The mean change from baseline in GMFM 66 in the control groups was 1.3 (SD=7.6)	The mean change from baseline in GMFM 66 in the intervention group was 0.65 lower (4.4 lower to 3.1 higher)	-	48 (1 RCT)	Low[3]
HrQOL: Change from baseline in AQOL-6D[7] follow up: 24 weeks	The mean change from baseline in the AQOL-6D score in the control group was -1.9 (SD=8.06)	The mean change from baseline in the AQOL-6D score in the intervention group was 0.30 higher (7.07 lower to 7.67 higher)	-	15[12] (1 RCT)	Very Low[3,8]
Independence- not reported	-	-	-	-	-
Fatigue: Change from baseline in Fatigue Severity Scale[9] follow up: 24 weeks	The mean change from baseline in fatigue severity scale in the control group was -1.9 (SD=12.5)	The mean change from baseline in fatigue severity scale in the intervention group was 1.30 higher (9.22 lower to 11.82 higher)	-	15[12] (1 RCT)	Very low[3,8]

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Strengthening or training programmes			
Frequency of falls: Change from baseline in Falls Efficacy Scale[10] follow up: 24 weeks	The mean change from baseline in the falls efficacy scale in the control group was -3.5 (SD=4.8)	The mean change from baseline in the falls efficacy scale in the intervention group was 5.3 lower (12 lower to 1.4 higher)	-	15[12] (1 RCT)	Low[3]
Complications of treatment: Participants reporting new soreness follow up: 24 weeks	Events in intervention 2/8	Events in control 0/8	RR 5.00 (0.28 to 90.18)	15[12] (1 RCT)	Low[3]
Adherence to treatment: Number of sessions attended follow up: 24 weeks	828 per 1000	860 per 1000 (702 to 941)	RR 1.04 (0.89 to 1.20)	15[12] (1 RCT)	Low[2,11]

AQOL-6D: Assessment of Quality of Life Instrument-6D; CI: confidence interval; GMFM: gross motor function measure; GRADE: grading of recommendations assessment development and evaluation; HrQOL: health related quality of life; RR: risk ratio; NGA: National Guideline Alliance; RCT: randomised controlled trial; SD: standard deviation

1. Higher change from baseline in 2 minute walk test indicates better participation; change from baseline scores calculated by NGA team
2. Downgraded for serious risk of bias due to unit of analysis issues – there were 8 observations for this outcome from each participant which are likely to be correlated
3. Downgraded for very serious imprecision due as confidence interval includes both MID thresholds
4. Change from baseline in 6 minute walk test: Higher value indicates better participation
5. Change from baseline in stair climbing: Higher value indicates better motor function
6. Change from baseline in GMFM 66: higher value indicates better motor function
7. Change in baseline in HrQOL: higher value indicates better health related quality of life
8. Downgraded for serious risk of bias due to lack of blinding in this subjective outcome
9. Change from baseline in fatigue severity scale: Lower value indicates better outcome
10. Change from baseline in falls efficacy scale: lower value indicates better outcome
11. Downgraded for serious imprecision as the confidence interval includes one MID threshold
12. Outcome data at week 24 were available for 15/17 participants.1 participant was lost to follow-up and 1 withdrew (both in the intervention group)

Table 6: Summary clinical evidence profile: Comparison 4: Task-oriented upper limb training versus standard care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Task-oriented upper limb training			
Participation: Change from baseline in Jebsen Hand Function Test[1] follow up: post-test at 12 weeks	The mean participation in the control groups was -1.99 (SD=15.08)	The mean participation in the intervention groups was 22.03 lower (52.25 lower to 8.19 higher)	-	17 (1 observational study)	Very low[2,6]
Physical function Change from baseline in Nine hole peg test[4] follow up: post-test at 12 weeks	The mean physical function in the control groups was -2.274 (SD=32.78)	The mean physical function in the intervention groups was 20.91 lower (48.99 lower to 7.18 higher)	-	17 (1 observational study)	Very low[2,3]
Health related quality of life- not reported	-	-	-	-	-
Independence Change from baseline in Barthel Index[5] follow up: post-test at 12 weeks	The mean independence in the control groups was 0 (SD=0)	Not estimable	-	17 (1 observational study)	Very low[2,7]
Fatigue- not reported	-	-	-	-	-

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Standard care	Task-oriented upper limb training			
Frequency of falls- not reported	-	-	-	-	-
Complications of treatment- not reported	-	-	-	-	-
Adherence- not reported	-	-	-	-	-

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; SD: standard deviation; SMD: standardized mean difference
1. Jebsen hand function test: Lower score indicates greater function. Change from baseline values calculated by NGA team
2. Downgraded for serious risk of selection bias, as the baseline characteristics of intervention and control groups are not reported (and no adjustments were made for confounders) and it is unclear how they were selected
3. Downgraded for serious imprecision as confidence interval includes one MID threshold
4. Nine hole peg test: lower scores indicate better function. Change from baseline values calculated by NGA team.
5. Barthel Index: Higher scores indicate more independence. Change from baseline values calculated by NGA team.
6. Downgraded for very serious imprecision as confidence interval includes both MID thresholds.
7. Mean and standard deviation of change from baseline in the standard care group were both zero, so mean difference could not be estimated.

Table 7: Summary clinical evidence profile: Comparison 5: Task oriented upper limb training, before versus after outcomes

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Before Upper limb training	After Upper limb training			
Participation - Motor Activity Log (amount of use)	The mean motor activity log score(amount of use) in the control group was 1.4 (SD=0.8)	The mean motor activity log score(amount of use) in the intervention groups was 0.20 higher (0.76 lower to 1.16 higher)	-	12 (1 observational study)	Very low[1,2]
Physical Function Nine hole peg test	The mean nine hole peg test score in the control groups was 96.3 (SD=66.2)	The mean 9 hole peg test score in the intervention groups was 3.90 lower(86.56 lower to 78.76 higher)	-	12 (1 observational study)	Very low[1,2]
Health related quality of life- not reported	-	-	-	-	-
Independence- not reported	-	-	-	-	-
Fatigue- not reported	-	-	-	-	-
Frequency of falls- not reported	-	-	-	-	-
Complications of treatment- not reported	-	-	-	-	-
Adherence- not reported	-	-	-	-	-

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; SD: standard deviation; SMD: standardized mean difference
1. Downgraded for serious risk of bias due to self-reporting of outcomes
2. Downgraded for very serious imprecision as the confidence interval included both MID thresholds

Table 8: Summary clinical evidence profile: Comparison 6: Orthopaedic surgery, pre- versus post-operative outcomes

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Preoperative	After Orthopaedic surgery			
Participation Participants Walking without aids Follow-up: mean 10 years	Not estimable	Not estimable	RR ranged from 1.25 (0.42 to 3.70) to 5.50 (2.09 to 14.49)	53 (2 observational studies)	Very low[1,2,3]
Physical function- Harris hip score	The mean Harris hip score before surgery was 36 (SD=11.2)	The mean Harris hip score after surgery was 42 higher (36.92 to 47.08 higher)	-	39 (1 observational study)	Very low[3]
Health related quality of life- not reported	-	-	-	-	-
Independence Participants conducting their own hygiene care Follow-up: mean 10 years	357 per 1000	429 more per 1000 (11 to 1000 more)	RR 2.20 (1.03 to 4.68)	14 (1 observational study)	Very low[1]
Fatigue- not reported	-	-	-	-	-
Frequency of falls- not reported	-	-	-	-	-
Complications of treatment- not reported	-	-	-	-	-

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; RR: Risk ratio; SD: standard deviation
1. Downgraded for very serious risk of bias due to selection bias and outcome assessment bias
2. Downgraded for serious inconsistency: one of the studies showed a clinically significant benefit with orthopaedic surgery whereas the other did not
3. Downgraded for serious risk of bias due to retrospective collection of data

See appendix F for the full GRADE tables.

Economic evidence

Included studies

A systematic review of the economic literature was conducted but no studies were identified which were applicable to this review question.

Excluded studies

No studies were identified which were applicable to this review question.

Summary of studies included in the economic evidence review

No economic evaluations were included in this review.

Economic model

This question was not prioritised for economic modelling. Given the legislation in place around the provision of powered mobility aids the committee did not believe that any recommendation would lead to a significant resource impact.

Resource impact

No unit costs were presented to the committee as these were not prioritised for decision-making purposes.

Evidence statements

Comparison 1: Physical activity intervention, before versus after outcomes

Critical outcomes

Participation incorporating mobility

- Very low quality evidence from 1 before-and-after study including 10 people indicated that a physical activity intervention did not improve participation as measured by walking efficiency (gait energy expenditure index).

Physical function

- Very low quality evidence from 1 before-and-after study including 10 people indicated that a physical activity intervention did not improve physical function as measured by the Gross Motor Function Measure (GMFM).

Health related quality of life & psychological wellbeing

- No evidence was found for this outcome.

Important outcomes

Independence

- No evidence was found for this outcome.

Fatigue

- No evidence was found for this outcome.

Frequency of falls

- No evidence was found for this outcome.

Complications of treatment

- No evidence was found for this outcome.

Adherence

- No evidence was found for this outcome.

Comparison 2: physical activity interventions versus standard care

Critical outcomes

Participation incorporating mobility

- Low quality evidence from 1 randomised controlled trial including 32 people with spastic cerebral palsy, indicated physical activity intervention was associated with a clinically significant improvement in participation (as measured by change in maximal gait speed) compared to standard care.

Physical function

- Low quality evidence from 1 randomised controlled trial including 26 adults with cerebral palsy, indicated physical activity intervention was associated with a clinically significant improvement in physical function (as measured by the total international classification of functioning score) compared to standard care.

Health related quality of life & psychological wellbeing

- No evidence was found for this outcome.

Important outcomes

Independence

- Low quality evidence from 1 randomised controlled trial including 26 adults with cerebral palsy, indicated physical activity intervention was associated with a clinically significant improvement in independence compared to standard care.

Fatigue

- No evidence was found for this outcome.

Frequency of falls

- No evidence was found for this outcome.

Complications of treatment

- No evidence was found for this outcome.

Adherence

- No evidence was found for this outcome.

Comparison 3: strengthening or training programmes versus standard care

Critical outcomes

Participation incorporating mobility

- Low quality evidence from 1 randomised controlled trial including 15 people with cerebral palsy indicated that a strengthening/training programme did not result in a clinically significant change in participation (as measured by a change from baseline in 2 min walk test) compared to standard care.

Physical function

- Low quality evidence from 2 randomised controlled trials including 60 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant change in physical function (as measured by the change from baseline in 6 min walk test) compared to standard care.
- Low quality evidence from1 randomised controlled trial including 12 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant change in physical function (as measured by a change from baseline in stair climbing) compared to standard care.
- Low quality evidence from1 randomised controlled trial including 48 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant change in physical function (as measured by a change from baseline in gross motor function measure 66) compared to standard care.

Health related quality of life & psychological wellbeing

- Very low quality evidence from 1 randomised controlled trial including 15 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant improvement in health related quality of life compared to standard care.

Important outcomes

Independence

- No evidence was found for this outcome.

Fatigue

- Very low quality evidence from 1 randomised controlled trial including 15 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant change in fatigue (as measured by the change from baseline on the fatigue severity scale) compared to standard care.

Frequency of falls

- Low quality evidence from 1 randomised controlled trial including 15 people with cerebral palsy indicated that a strengthening/training programme did not bring clinically significant improvement in falls (as measured by the change from baseline on the falls efficacy scale) compared to standard care.

Complications of treatment

- Low quality evidence from 1 randomised controlled trial including 16 people with cerebral palsy indicated that a strengthening/training programme led to a clinically significant increase in treatment related adverse effects (as in the numbers of participants reporting soreness) compared to standard care.

Adherence

- Low quality evidence from 1 randomised controlled trial including 15 people with cerebral palsy indicated a similar adherence to a strengthening/training programme (measured in number of sessions attended) as there was to standard care.

Comparison 4: task-oriented upper limb training versus standard care

Critical outcomes

Participation incorporating mobility

- Very low quality evidence from 1 non randomised controlled study including 17 people with cerebral palsy indicated that a task oriented upper limb programme did not bring clinically significant change in participation (as measured by the change from baseline on Jebsen Hand Function Test).

Physical function

- Very low quality evidence from 1 non randomised controlled study including 17 people with cerebral palsy indicated that a task oriented upper limb programme did not bring clinically significant change in physical function (as measured by the change from baseline on the nine hole peg test).

Health related quality of life & psychological wellbeing

- No evidence was found for this outcome.

Important outcomes

Independence

- Very low quality evidence from 1 non randomised controlled study including 17 people with cerebral palsy indicated that a task oriented upper limb programme did not bring clinically significant change in independence (as measured by the change from baseline on the Barthel index).

Fatigue

- No evidence was found for this outcome.

Frequency of falls

- No evidence was found for this outcome.

Complications of treatment

- No evidence was found for this outcome.

Adherence

- No evidence was found for this outcome.

Comparison 5: Task oriented upper limb training, before versus after outcomes

Critical outcomes

Participation incorporating mobility

- Very low quality evidence from one before-and-after study including 12 people with cerebral palsy with predominantly unilateral involvement of the upper limb indicated that task oriented upper limb programme did not bring clinically significant change in participation (as measured by the motor activity log).

Physical function

- Very low quality evidence from one before-and-after study including 12 people with cerebral palsy with predominantly unilateral involvement of the upper limb indicated that task oriented upper limb programme did not bring clinically significant change in physical function (as measured by the nine hole peg test).

Health related quality of life & psychological wellbeing

- No evidence was found for this outcome.

Important outcomes

Independence

- No evidence was found for this outcome.

Fatigue

- No evidence was found for this outcome.

Frequency of falls

- No evidence was found for this outcome.

Complications of treatment

- No evidence was found for this outcome.

Adherence

- No evidence was found for this outcome.

Comparison 6: Orthopaedic surgery, pre- versus post-operative outcomes

Critical outcomes

Participation incorporating mobility

- Very low quality evidence from 2 before-and-after study including 53 ambulatory adults with cerebral palsy with severely limited functional ability indicated that hip arthroplasty did not result in a clinically significant change in participation (as measured by the number of participants walking without aids).

Physical function

- Very low quality evidence from 1 before-and-after studies including 39 adults with cerebral palsy indicated that hip arthroplasty resulted in a clinically significant improvement in physical function (as measured by the Harris hip score).

Health related quality of life & psychological wellbeing

- No evidence was found for this outcome.

Important outcomes

Independence

- Very low quality evidence from 1 before-and-after study including 14 ambulatory people with cerebral palsy with severely limited functional ability indicated that hip arthroplasty brought clinically significant improved independence (as measured by the number of participants able to conduct their own hygiene care).

Fatigue

- No evidence was found for this outcome.

Frequency of falls

- No evidence was found for this outcome.

Complications of treatment

- No evidence was found for this outcome.

Adherence

- No evidence was found for this outcome.

References

Ballaz 2011

Ballaz L, Plamondon S, Lemay M. Group aquatic training improves gait efficiency in adolescents with cerebral palsy. Disabil Rehabil. 2011;33(17-18):1616-24. doi: 10.3109/09638288.2010.541544.

Brown 2010

Brown, S. H., Lewis, C. A., McCarthy, J. M., Doyle, S. T., Hurvitz, E. A., The effects of Internet-based home training on upper limb function in adults with cerebral palsy, Neurorehabilitation and neural repair, 24, 575-83, 2010

Houdek 2017

Houdek, M. T., Watts, C. D., Wyles, C. C., Trousdale, R. T., Milbrandt, T. A., Taunton, M. J., Total Hip Arthroplasty in Patients with Cerebral Palsy: A Cohort Study Matched to Patients with Osteoarthritis, The Journal of bone and joint surgery, American volume. 99, 488-493, 2017

Hutzler 2013

Hutzler, Y., Rodriguez, B. L., Laiz, N. M., Diez, I., Barak, S., The effects of an exercise training program on hand and wrist strength, and function, and activities of daily living, in adults with severe Cerebral Palsy, Research in Developmental Disabilities, 34, 4343-4354, 2013

Lorentzen 2017

Lorentzen, J., Kirk, H., Fernandez-Lago, H., Frisk, R., Jensen, P., Nielsen, J. B., Randomised controlled clinical trial of the effect of gait training on muscle function and gait kinematics in adults with cerebral palsy, Developmental Medicine and Child Neurology, 58, 44, 2016

Maeland 2009

Maeland,S., Jahnsen,R., Opheim,A., Froslie,K.F., Moe-Nilssen,R., Stanghelle,J.K., No effect on gait function of progressive resistance exercise in adults with cerebral palsy A single-blind randomized controlled trial, Advances in Physiotherapy, 11, 227-233, 2009

Morgan 2015

Morgan, P., Murphy, A., Opheim, A., Pogrebnoy, D., Kravtsov, S., McGinley, J., The safety and feasibility of an intervention to improve balance dysfunction in ambulant adults with cerebral palsy: a pilot randomized controlled trial, Clinical Rehabilitation, 29, 907-19, 2015

Schroeder 2010

Schroeder K, Hauck C, Wiedenhöfer B, Braatz F, Aldinger PR. Long-term results of hip arthroplasty in ambulatory patients with cerebral palsy. Int Orthop. 2010 ;34(3):335-9

Taylor 2013

Taylor, N. F., Dodd, K. J., Baker, R. J., Willoughby, K., Thomason, P., Graham, H. K., Progressive resistance training and mobility-related function in young people with cerebral palsy: A randomized controlled trial, Developmental Medicine and Child Neurology, 55, 806-812, 2013

Teixeira-Machado 2017

Teixeira-Machado, L., Azevedo-Santos, I., DeSantana, J. M., Dance Improves Functionality and Psychosocial Adjustment in Cerebral Palsy: A Randomized Controlled Clinical Trial, American journal of physical medicine & rehabilitation, 96, 424-429, 2017

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

The critical outcomes were participation, physical function and health related quality of life because interventions to maintain physical function are primarily aimed at improving these outcomes. Important outcomes were independence, fatigue, frequency of falls, complications and adherence to the intervention programme.

The quality of the evidence

Evidence for outcomes related to participation and physical function following physical activity interventions was very low to low using GRADE. This was because of imprecision in evidence from one before-and-after study and risk of bias and imprecision in two randomized controlled trials in 1 randomised controlled trial. The low quality of the evidence meant that strong recommendation for physical activity interventions could not be made. For this comparison the number of reported outcomes was limited to: walking efficiency, gross motor function, independence and change in maximal gait speed.

The evidence to assess the effectiveness of strengthening/training programmes came from three randomised controlled trials. The evidence was low to very low using GRADE due to imprecision and risk of bias due to lack of blinding.

The evidence for task oriented upper limb training programmes for outcomes related to participation, physical function and independence was very low quality using GRADE. The evidence came from one before-and-after study and one non randomised controlled trial and was downgraded for imprecision, risk of due to selective reporting and assessment of outcomes.

The evidence for outcomes related to participation, physical function, independence following orthopaedic surgery was very low quality using GRADE. There were several limitations to this evidence including inconsistency, imprecision and high risk of selection and outcome assessment bias.

The committee discussed the practicality of the interventions in the randomised controlled trials and agreed that these interventions were not generalisable due to access to these specific services.

Benefits and harms

Low quality evidence from one randomised controlled trial showed that physical activity intervention can improve physical function and independence. Based on their knowledge and experience committee members agreed that physical activity helps in maintaining general fitness and healthy weight in all people, including adults who have physical disability. Hence, there should be discussions with adults with cerebral palsy about appropriate physical activities that could help in maintaining general fitness, range of movement and healthy weight. The committee agreed that information about local services should be provided in order to raise awareness and encourage the uptake of physical activities.

Based on their knowledge and expertise, the committee discussed that referral to a physiotherapist or an occupational therapist may be appropriate to suggest or initiate physical activities which would help in maintaining general fitness, range of movement, healthy weight, muscle strength and flexibility of joints. They acknowledged that this was consistent with NHS guidance on choosing mobility equipment, wheelchairs and scooters which states that assessing the need for such equipment would be carried out by a multidisciplinary team which may include occupational therapists or physiotherapists, and

rehabilitation engineers within a seating service. Even though there was no specific evidence identified the committee also noted, based on their experience and expertise that orthotic and functional electronic stimulation (FES) services can also provide help people participate in physical activities (including sport) and tasks of daily living. These are used in conjunction with other interventions to optimise treatment. If there is local service provision then referral to these services could also be considered.

The evidence showed that there were no serious adverse events associated with strengthening training interventions to maintain physical function (in other words there were no clear differences between intervention and control for frequency of falls, fatigue and soreness). This was an important finding because assumptions may be made that there are more risks associated with physical activities for adults with cerebral palsy compared to the general population. The committee agreed that access to mobility aids, including wheelchairs, is fundamental to participation in work, social and leisure activities and therefore made a recommendation that adults can be referred to rehabilitation engineering services that would provide such aids.

The committee also discussed the reported benefit of surgical interventions and the limited availability of surgeons with expertise in cerebral palsy. The committee noted that the evidence for orthopaedic surgery was very low quality with uncertainty around the outcomes. For this reason, the committee did not make a strong recommendation for orthopaedic surgery, instead they recommended considering referral to a specialist orthopaedic surgeon with experience and expertise in managing musculoskeletal pain in adults with cerebral palsy, if participation in physical activities is limited by pain or joint problems resistant to other measures. The committee noted that there is currently limited access to orthopaedic surgeons with expertise in cerebral palsy. Based on their knowledge and experience the committee agreed that a general orthopaedic surgeon may refer adults with cerebral palsy onwards to others with specific technical expertise (for example hip arthroplasty) within regional networks, but the referring surgeon would usually look after the rehabilitation aspects.

The committee discussed that there was a lot of variation in how orthoses were used in current practice. There was a lack of evidence in relation to this and the committee decided to make a research recommendation. They agreed that this was important because cerebral palsy is a condition that affects an individual over the course of their life and as a consequence there are different disorders of motor control that may occur. There are treatments aimed at improving posture and function in the upper limbs that result from these issues which include postural interventions (stretching or exercise), systemic pharmacological treatments (drugs) and focal pharmacological treatments (botulinum toxin or nerve blocks). Orthotic treatment includes the application of a rigid or flexible device to facilitate a positional change and function. It can be used in conjunction with these interventions or as a separate treatment. It is not known which types, intensities or durations of orthotic interventions applied either alone or as part of a multi-modal treatment strategy are effective in improving and maintaining posture or functional abilities in the upper limb. Therefore further research would provide important new information to guide practice in this area.

Cost effectiveness and resource use

No economic evaluations were identified for this topic.

Adults with cerebral palsy are encouraged to participate in activity and exercise that is available to the general population and usually not funded by the NHS, leading to no additional use of NHS resources. The committee noted that there may be individuals who would benefit from tailored physical activities and specialist advice. For example, when strength and resistance training is performed, supervision is key to ensure the exercise is performed correctly to reduce injuries and increase adherence. Furthermore, if specialist

advice is needed, referrals to physiotherapy or occupational therapy teams that have experience in dealing with neurological impairments should be considered as their expertise will help individuals to overcome (physical or emotional) barriers cerebral palsy can put up.

The committee agreed the initial costs of specialist advice would be negligible compared to the potential downstream cost savings from avoided injuries or inactivity. It was noted that recommending a healthcare professional to provide advice without experience dealing with neurological impairments, whilst less costly, may not provide any additional benefits.

The committee agreed it would not be appropriate or necessary to offer physiotherapy and occupational therapy services to all adults with cerebral palsy (this would also not be cost effective) and made a recommendation to consider a referral to those that need help overcoming barriers to physical activities or functional tasks.

No comparative evidence was identified on orthotics and wheelchairs which limited the committee's ability to make strong recommendation on relatively expensive interventions. However, given that existing NHS commissioning policies are in place for those interventions, the committee agreed it was likely cost effective to offer a referral so their needs can be assessed. The committee noted that a recommendation to offer referrals would increase the overall number given that practice is currently variable across England. However, this would be offset by the improved quality of life that greater independence will bring.

The committee also added that manual wheelchairs and powered wheelchairs will differ in their cost effectiveness and iterated the importance of weighing up their potential harms and benefits on an individual basis. For example, manual wheelchairs will be cheaper to purchase and maintain, but may have negative effects if they cause harm by being too heavy to operate or increase shoulder or back pain and can also limit participation.

Referrals for orthopaedic surgery are usually considered by a neurodisability specialist when other less invasive and less costly methods such as tone management are no longer effective. To reflect this, the committee's recommendations followed the stepwise approach taken in current practice. The committee referred to the single study on hip surgery that was included and agreed that other joints such as the elbow can also be targeted, adding that the cost of surgery will depend on the joint that is targeted. To prevent considerations of hip surgery alone, the committee did not specify the type of orthopaedic surgery in their recommendation as this should be individualised to the person's need.

Other factors the committee took into account

The committee also discussed access to wheelchairs (manual or powered). Regarding the use of wheelchairs, the committee highlighted that even though no evidence was identified there is legislation, which informed this. This is covered by the UN Convention on disability rights which has been agreed by the UK to protect and promote the rights of disabled people and Article 20 which asks nations 'to ensure personal mobility with the greatest possible independence for persons with disabilities'.

Appendices

Appendix A – Review protocols

Review protocol for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Table 9: Review protocol for interventions for maintaining physical function

Field (based on PRISMA-P)	Content
Review question	D2 Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy, for example: • physical activity • strengthening programmes or training • orthotics • task-oriented upper limb training • orthopaedic surgery (including tendon lengthening and orthopaedic bony procedures in adulthood) • powered mobility aids and wheelchairs
Type of review question	Intervention
Objective of the review	This review aimed to compare the effectiveness of interventions for maintaining or improving physical function and mobility in adults with cerebral palsy.
Eligibility criteria – **population**/disease/condition/issue/domain	Adults aged 16 and over with cerebral palsy
Eligibility criteria – **intervention**(s)/exposure(s)/prognostic factor(s)	• physical activity (exercise, sport, community leisure) • strengthening programmes or training • orthotics (FES – related guidance)

Field (based on PRISMA-P)	Content
	• task-oriented upper limb training • orthopaedic surgery (including tendon lengthening, wrist fixation, long finger flexor release, hip surgery for dislocation, adductor tendon release, hamstring release, and orthopaedic bony procedures in adulthood) • Powered Mobility aids and wheelchairs
Eligibility criteria – **comparator(s)**/control or reference (gold) standard	• Each other • Usual care
Outcomes and prioritisation	**Critical outcomes** • Participation (incorporating mobility) • Physical function • Health related quality of life & psychological wellbeing **Important outcomes** • Independence • Fatigue • Frequency of falls [in a subset] • Complications of treatment • Adherence Minimally important differences: For this review protocol there were a number of published minimally important differences. For a description of these is provided in the methods in supplementary document C.
Eligibility criteria – **study design**	Only published full text papers – conference abstracts will not be considered. • Systematic reviews of RCTs • RCTs - are cross over RCTs appropriate for this question? • Comparative cohort studies (only if RCTs unavailable or limited data to inform decision making)
Other inclusion **exclusion criteria**	None
Proposed sensitivity/**sub-group analysis**, or meta-regression	In the presence of heterogeneity, the following subgroups will be considered for sensitivity analysis: • Population subgroups ○ GMFCS level I to II

Field (based on PRISMA-P)	Content
	○ GMFCS III to IV ○ GMFCS V ○ Different patterns of motor disorder ○ Proportion with cerebral palsy (studies including other non-progressive causes of neuro-disability should involve at least 50% people with cerebral palsy) • Intervention subgroups (e.g. route of administration, drugs within drug classes, high/low dose): ○ Type of physical activity ○ Type of orthopaedic surgery ○ Initiation, duration and frequency of intervention (the timing of when someone receives a wheelchair or mobility aid is an important consideration) Age and GMFCS level will be also considered important confounders which ideally should be adjusted for in any included comparative observational studies. Indicate any modifiers of treatment effect/confounders that will be used to try to explain heterogeneity.
Selection process – duplicate screening/selection/analysis	A random sample of the references identified in the search will be sifted by a second reviewer. This sample size will be 10% of the total, or 100 studies if the search identifies fewer than 1000 studies. All disagreements in study inclusion will be discussed and resolved between the two reviewers. The senior systematic reviewer or guideline lead will be involved if discrepancies cannot be resolved between the two reviewers.
Data management (software)	Pairwise meta-analyses were performed using Cochrane Review Manager (RevMan5). 'GRADEpro' was used to assess the quality of evidence for each outcome.
Information sources – databases and dates	Embase 1974 to 2018 March 22, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present Last searched on 22/03/2018
Identify if an update	Not an update
Author contacts	For details please see the guideline in development web site.
Highlight if amendment to previous protocol	For details please see section 4.5 of Developing NICE guidelines: the manual 2014
Search strategy – for one database	For details please see appendix B.
Data collection process – forms/duplicate	A standardised evidence table format will be used, and published as appendix D (clinical evidence tables) or H (economic evidence tables).

Field (based on PRISMA-P)	Content
Data items – define all variables to be collected	For details please see evidence tables in appendix D (clinical evidence tables) or H (economic evidence tables).
Methods for assessing bias at outcome/study level	Standard study checklists were used to critically appraise individual studies. For details please see section 6.2 of Developing NICE guidelines: the manual 2014 The risk of bias across all available evidence was evaluated for each outcome using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group http://www.gradeworkinggroup.org/.
Criteria for quantitative synthesis	For details please see section 6.4 of Developing NICE guidelines: the manual 2014
Methods for quantitative analysis – combining studies and exploring (in)consistency	For details please see supplementary document C for a description of the methods used for the quantitative analysis.
Meta-bias assessment – publication bias, selective reporting bias	For details please see section 6.2 of Developing NICE guidelines: the manual 2014.
Confidence in cumulative evidence	For details please see sections 6.4 and 9.1 of Developing NICE guidelines: the manual.
Rationale/context – what is known	For details please see the introduction to the evidence review.
Describe contributions of authors and guarantor	A multidisciplinary committee developed the evidence review. The committee was convened by the National Guideline Alliance (NGA) and chaired by Dr Paul Eunson in line with section 3 of Developing NICE guidelines: the manual 2014. Staff from the NGA undertook systematic literature searches, appraised the evidence, conducted meta-analysis and cost effectiveness analysis where appropriate, and drafted the guideline in collaboration with the committee. For details please see the methods in supplementary document C.
Sources of funding/support	The NGA is funded by NICE and hosted by the Royal College of Obstetricians and Gynaecologists.
Name of sponsor	The National Guideline Alliance is funded by NICE and hosted by the Royal College of Obstetricians and Gynaecologists
Roles of sponsor	NICE funds NGA to develop guidelines for those working in the NHS, public health and social care in England
PROSPERO registration number	Not applicable

GRADE: Grading of Recommendations Assessment, Development and Evaluation; GMFCS, gross motor function classification system; ICF: International Classification of Functioning, Disability and Health; MID: minimally important difference; NGA: National Guideline Alliance; NHS: National Health Service; NICE: National Institute for Health and Care Excellence; RCT: randomised controlled trial; RoB: risk of bias; SD: standard deviation.

Appendix B – Literature search strategies

Literature search strategies for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

This appendix is a combined search strategy and will be the same for all the evidence reviews for the D review questions as listed below:

D1: Which interventions (for example, vocational and independent living skills training) promote participation in adults with cerebral palsy?

D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

D3: What is the effectiveness of electronic assistive technology in promoting independence in adults with cerebral palsy?

D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Database: Medline & Embase (Multifile)

Database(s): Embase 1974 to 2018 March 22, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present

Table 10: Last searched on 22 March 2018

#	Searches
1	exp Cerebral Palsy/ use prmz
2	exp cerebral palsy/ use oemezd
3	((cerebral or brain or central) adj2 (pal* or paralys#s or pares#s)).tw.
4	cerebral palsy.ti,ab.
5	little? disease.tw.
6	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) adj5 spastic*).tw.

#	Searches
7	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) adj3 ataxi*).tw.
8	or/1-7
9	limit 8 to english language
10	limit 9 to (adult <18 to 64 years> or aged <65+ years>) use oemezd [Limit not valid in Ovid MEDLINE(R),Ovid MEDLINE(R) In-Process; records were retained]
11	limit 9 to "all adult (19 plus years)" [Limit not valid in Embase; records were retained]
12	11 use prmz
13	or/10,12
14	exp Community Participation/ or exp Social Participation/ or exp "Activities of Daily Living"/ or exp Independent Living/ or exp Vocational Education/ or exp "Quality of Life"/ or exp Hearing Aids/ or exp Wheelchairs/ or exp Needs Assessment/ or exp Disability Evaluation/ or exp Self-Help Devices/ or exp Sickness Impact Profile/ or exp Sensory Aids/ or exp "Prostheses and Implants"/ or exp Orthotic Devices/ or exp Equipment Design/ or exp User-Computer Interface/ or exp communication aids for disabled/ or exp speech disorder/rh or exp Exercise/ or exp Rehabilitation/mt or exp Sports/ or exp Exercise Therapy/ or exp Orthopedic Procedures/ or exp Physical Therapy Modalities/
15	14 use prmz
16	social behavior/ or exp social adaptation/ or exp social participation/ or exp social interaction/ or exp community integration/ or exp community living/ or exp daily life activity/ or exp independent living/ or exp vocational education/ or exp "quality of life"/ or exp hearing aid/ or exp wheelchair/ or exp needs assessment/ or exp disability/ or exp self help device/ or exp Sickness Impact Profile/ or exp sensory aid/ or exp "prostheses and orthoses"/ or exp orthosis/ or exp implant/ or exp equipment design/ or exp computer interface/ or exp exercise/ or exp rehabilitation/ or exp self help/ or exp assistive technology/ or exp vocational guidance/ or exp communication aid/ or exp facilitated communication/ or exp eye tracking/ or exp sport/ or exp kinesiotherapy/ or exp orthopedic surgery/ or exp physiotherapy/
17	16 use oemezd
18	(participat* or (daily adj activit*) or (independen* adj5 liv*) or age* or aging or gender or motivat* or preference* or limitation* or restriction* or capacit* or performance* or (handl* adj5 object*) or assistive technolog* or (social adj5 interaction*) or employ* or vocation* or occupat* or educat* or profession* or isolat* or leisure activit* or mobil* or communicat* or eat* or dining or drink* or dress* or interact* or ((assistive or adaptive) adj5 (technolog* or device* or system*)) or home or school or work* or communit* or play* or eye tracking or sporting activit* or swim* or aqua* or upper limb training or bony procedure* or (neuro-developmental adj (treatment* or therap* or training)) or NDT or (muscle adj (tissue or tone)) or ((strength* or endurance) adj5 (program* or training*)) or ((tendon* or muscle*) adj (length* or stretch*)) or treadmill* or weight*).tw.
19	(augmentative or alternative communication or AAC or voice synthesizer* or accommodation* or sign language or gestur* or manual language board* or high?tech or touch screen* or speech?generating* or electronic keyboard* or phone* or iPad* or laptop* or computer* or modificat* or modify* or adapt* or custom* or tailor* or assist* or ((walking or hearing) adj aid*) or (communication adj (device* or system* or board*))).ti,ab.
20	15 or 17 or 18 or 19
21	13 and 20
22	conference abstract.pt. use oemezd
23	letter.pt. or LETTER/ use oemezd
24	Letter/ use prmz
25	EDITORIAL/ use prmz

#	Searches
26	editorial.pt. use oemezd
27	NEWS/ use prmz
28	exp HISTORICAL ARTICLE/ use prmz
29	note.pt. use oemezd
30	ANECDOTES AS TOPIC/ use prmz
31	COMMENT/ use prmz
32	CASE REPORT/ use prmz
33	CASE REPORT/ use oemezd
34	CASE STUDY/ use oemezd
35	(letter or comment* or abstracts).ti.
36	or/22-35
37	RANDOMIZED CONTROLLED TRIAL/ use prmz
38	RANDOMIZED CONTROLLED TRIAL/ use oemezd
39	random*.ti,ab.
40	or/37-39
41	36 not 40
42	ANIMALS/ not HUMANS/ use prmz
43	ANIMAL/ not HUMAN/ use oemezd
44	exp ANIMALS, LABORATORY/ use prmz
45	exp ANIMAL EXPERIMENTATION/ use prmz
46	exp MODELS, ANIMAL/ use prmz
47	exp RODENTIA/ use prmz
48	NONHUMAN/ use oemezd
49	exp ANIMAL EXPERIMENT/ use oemezd
50	exp EXPERIMENTAL ANIMAL/ use oemezd
51	ANIMAL MODEL/ use oemezd
52	exp RODENT/ use oemezd
53	(rat or rats or mouse or mice).ti.
54	or/41-53
55	21 not 54

Database: Cochrane Library

Table 11: Last searched on 22 March 2018

Hits	Search
#1	MeSH descriptor: [Cerebral Palsy] explode all trees and with qualifier(s): [Physiopathology - PP, Rehabilitation - RH]
#2	((cerebral or brain or central) N2 (pal* or paralys?s or pare?s))
#3	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) N5 spastic*)
#4	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) N3 ataxi*)
#5	#1 or #2 or #3 or #4

Hits	Search
#6	MeSH descriptor: [Social Behavior] explode all trees
#7	MeSH descriptor: [Social Participation] explode all trees
#8	MeSH descriptor: [Interpersonal Relations] explode all trees
#9	MeSH descriptor: [Community Integration] explode all trees
#10	MeSH descriptor: [Independent Living] explode all trees
#11	MeSH descriptor: [Activities of Daily Living] explode all trees
#12	MeSH descriptor: [Vocational Education] explode all trees
#13	MeSH descriptor: [Quality of Life] explode all trees
#14	MeSH descriptor: [Hearing Aids] explode all trees
#15	MeSH descriptor: [Wheelchairs] explode all trees
#16	MeSH descriptor: [Needs Assessment] explode all trees
#17	MeSH descriptor: [Disability Evaluation] explode all trees
#18	MeSH descriptor: [Self-Help Devices] explode all trees
#19	MeSH descriptor: [Sickness Impact Profile] explode all trees
#20	MeSH descriptor: [Sensory Aids] explode all trees
#21	MeSH descriptor: [Prostheses and Implants] explode all trees
#22	MeSH descriptor: [Orthotic Devices] explode all trees
#23	MeSH descriptor: [Equipment Design] explode all trees
#24	MeSH descriptor: [User-Computer Interface] explode all trees
#25	MeSH descriptor: [Exercise] explode all trees
#26	MeSH descriptor: [Rehabilitation] explode all trees
#27	MeSH descriptor: [Vocational Guidance] explode all trees
#28	MeSH descriptor: [Communication Aids for Disabled] explode all trees
#29	MeSH descriptor: [Eye Movements] explode all trees
#30	MeSH descriptor: [Sports] explode all trees
#31	MeSH descriptor: [Exercise Therapy] explode all trees
#32	MeSH descriptor: [Orthopedic Procedures] explode all trees
#33	MeSH descriptor: [Physical Therapy Modalities] explode all trees
#34	sporting activit* or swim* or aqua* or upper limb training or bony procedures or Neuro-developmental near (Treatment* or therap* or training) or NDT or muscle tissue or muscle tone or strength* or endurance or length* or stretch* or treadmill* or weight*
#35	participat* or independent liv* or age or aging or limitation* or restriction* or capacit* or performance* or Assistive technolog* or augmentative communication or alternative communication or AAC or employ* or vocation* or occupat* or educat* or profession* or leisure activit* or interaction* or home or school or work* or communit* or play* or accommodation* or sign language or gestur* or manual language board* or high?tech or touch screen* or speech?generating* or electronic keyboard* or phone* or iPad* or laptop* or computer or eye tracking or modif* or adapt* or custom* or tailor* or assist* or walking aid* or hearing aid*
#36	{or #6-#35}
#37	#5 and #36

Database: Web of Science

Table 12: Last searched on 22 March 2018

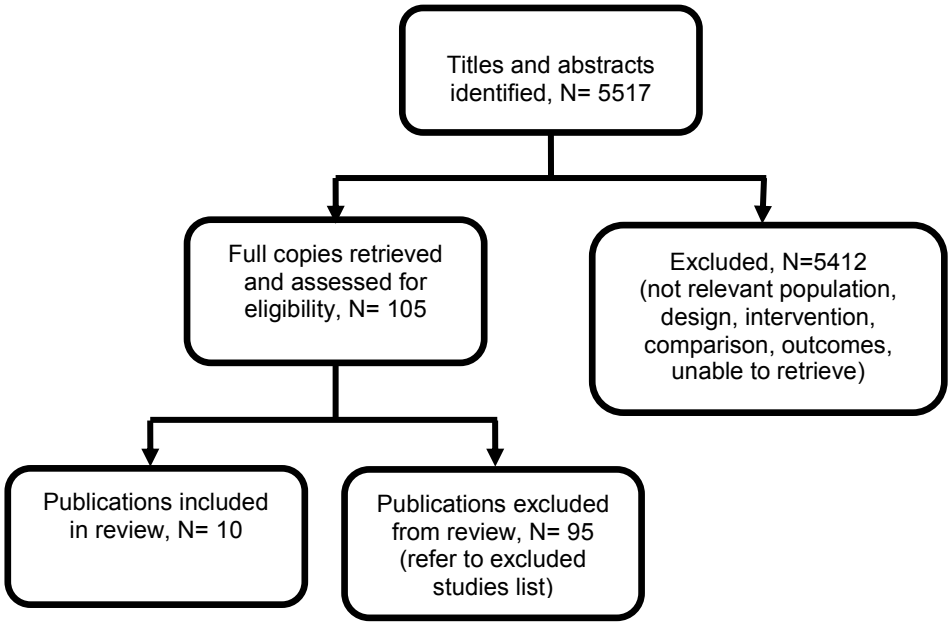
#3	#2 AND #1 AND LANGUAGE: (English)
#2	ts=Social Behavior or ts=Social Participation or ts=Interpersonal Relations or ts=Community Integration or ts=Independent Living or ts=Activities of Daily Living or ts=Vocational Education or ts=Quality of Life or ts=Hearing Aid* or ts=Wheelchair* or ts=Disability Evaluation or ts=Needs Assessment or ts=Self-Help Device* or ts=Sensory Aid* or ts=Prostheses or ts=Implant* or ts=Orthotic Device* or ts=Equipment Design or ts=User-Computer Interface or ts=Exercise* or ts=Rehabilitation or ts=Vocational Guidance or ts=Sport* or ts=Exercise Therap* or ts=Orthopedic Surgery or ts=Physiotherapy OR TS=Assistive technolog* or TS=augmentative communication or TS=alternative communication or TS=AAC OR TS=manual language board* or TS=high?tech or TS=touch screen* or TS=speech?generating* or TS=electronic keyboard* or TS=phone* or TS=iPad* or TS=laptop* or TS=eye tracking
#1	ts=Cerebral Palsy

Appendix C – Clinical evidence study selection

Clinical evidence study selection for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Figure 1: Flow diagram of clinical article selection for interventions for physical function review



Appendix D – Clinical evidence tables

Clinical evidence tables for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Table 13: Studies included in the evidence review for interventions for maintaining physical function in adults with cerebral palsy

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Full citation Ballaz,L., Plamondon,S., Lemay,M., Group aquatic training improves gait efficiency in adolescents with cerebral palsy, Disability and Rehabilitation, 33, 1616-1624, 2011 **Ref Id** 132595	**Sample size** 12 **Characteristics** 12 adolescents. Average age: 17. 25 yrs (14-21 yrs) GMFCS I = 2, II=4, III=4, IV=2. **Inclusion criteria** 1) Ability to follow simple verbal instructions	**Interventions** Aquatic training programme that focused mainly on swimming. It included 20 group training sessions supervised by physical therapists and sports teacher (45 min/twice a week). Session Duration = Warm Up + 15 min race relay + 5 min cool down + 15 min water polo/volley ball	**Details** Three physical therapists and a sports teacher supervised the training sessions. Participants wore a heart rate monitor to assess sessions' intensity and a floatation device as appropriate. The primary outcome measure was gait efficiency as measured by the gait energy expenditure index (EEI).2 participants	**Results** See Forest Plots	**Limitations** 1) Single group study 2) Small sample size **Other information** **Limitations** EPOC Quality criteria for interrupted time series (ITS)

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Canada **Study type** Single group pre-post design **Aim of the study** To evaluate the effect and feasibility of a 10-week group aquatic training programme in adolescents with cerebral palsy (CP). **Study dates** not reported **Source of funding** Not reported	2) Independent in walking (with or without assistive devices) for at least 5 min **Exclusion criteria** 1) Any known cardiovascular disease 2) Surgical intervention or Botulinum toxin A injection in the lower extremities		dropped out at week 5.		Protection against secular changes - done Data were analysed appropriately - not done Sample size calculation performed - not done Shape of the intervention effect was specified - not clear Protection against detection bias: Intervention unlikely to affect data collection - done Protection against detection bias: Blinded assessment of primary outcome(s) - not done
Full citation	**Sample size**	**Interventions**	**Details**	**Results**	**Limitations**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Brown, S. H., Lewis, C. A., McCarthy, J. M., Doyle, S. T., Hurvitz, E. A., The effects of Internet-based home training on upper limb function in adults with cerebral palsy, Neurorehabilitation and neural repair, 24, 575-83, 2010 **Ref Id** 416064 **Country/ies where the study was carried out** United States **Study type** Uncontrolled Before-and-after study **Aim of the study** The purpose of this study was to examine the	12 **Characteristics** Age: 21 to 57 years (mean age, 33 years and 11 months ± 10 years) Gender: 4 males, 8 females Limb involvement: Predominantly unilateral involvement of the upper limb (GMFCS [Gross Motor Function Classification System for Cerebral Palsy] levels I, II)-10, , GMFCS level III-1, GMFCS level IV- 1 **Inclusion criteria** 1) Adults with cerebral palsy with predominantly unilateral	Intervention Equipment: An upper limb training system consisting of a laptop, webcam, target light board, and hand manipulation/ discrimination devices . Intervention Task: unilateral and bilateral reach movements as well as a series of hand sensorimotor tasks such as card turning, stereognosis, and tactile discrimination. Site of intervention: Home Intensity/Duration: 40 min/day, 5 days/wk for 8 wks	Data generated during each session were transmitted to the laboratory via the Internet. Main outcome measures were movement time, interlimb delay time, and performance on hand sensorimotor tasks.	See Forest Plots	1) No control group 2) small sample size **Other information** **Limitations** Risk of Bias Using New Castle Ottawa Checklist for non randomised studies Selection:4/4 1) Representativeness of the exposed cohort: Somewhat representative* 2) Selection of the non exposed cohort: drawn from the same community as cohort* 3) Ascertainment of exposure: webcams * 4) Demonstration that outcome of interest was not

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
effectiveness of a home and Internet-based upper limb training program for adults with hemiplegic CP **Study dates** Not mentioned **Source of funding** This study was supported by a field-initiated grant awarded to SHB from the National Institute on Disability and Rehabilitation Research (H133G050151) and research fellowships awarded to CAL from the Office of Special Education and Rehabilitative Services Leadership Training Program (H325D020028) and the University of Michigan Medical Rehabilitation NIH	involvement of upper limb 2) Independent community dwellers 3) Able to extend each finger of the affected hand by at least 10°. **Exclusion criteria** Receiving medical treatment related to upper limb function.				present at the start of study: yes* Comparability:1/2 1) Comparability of cohorts on the basis of the design or analysis: * Outcome:1/3 1) Assessment of outcome: Not blind assessment 2) Was follow-up enough for outcomes to occur: yes* 3) Adequacy of follow up of cohorts: 2 dropped out

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Training Program (HD007422-15).					
Full citation Hutzler, Y., Rodriguez, B. L., Laiz, N. M., Diez, I., Barak, S., The effects of an exercise training program on hand and wrist strength, and function, and activities of daily living, in adults with severe Cerebral Palsy, Research in Developmental Disabilities, 34, 4343-4354, 2013 **Ref Id** 416051 **Country/ies where the study was carried out** Spain **Study type**	**Sample size** 17 **Characteristics** Intervention group: 10 participants (six males and four females) with a mean age of 46.80, SD=11.35 years. Functional classification GMFCS levels II (n = 2), III (n = 5) and IV (n = 3). Control group: 7 participants (four males and three females) with a mean age of 39.85, SD=14.43 years and GMFCS levels III (n = 3) and IV (n = 4). All participants were Caucasian. **Inclusion criteria**	**Interventions** Total duration: 3 months First 4 weeks: Familiarizing participants with equipment & exercises Next 8 weeks: Main training period: 3 training sessions each (totalling 24 sessions) lasted a net time of 90 min within a two and a-half hour total time. Each session included four parts: (a) 10 min of warm-up and flexibility training of the upper extremity and trunk joints; (b) main specific training of the major muscle groups (biceps brachii, triceps brachii, pectoralis major and deltoid) during a 40–50 min duration;	**Details** A control group design mixed with a prospective time series design for the experimental group was completed, including a pre-test, a post-test after a 12-week intervention period, and a follow-up in the experimental group after an additional 10- week period.	**Results** The test battery was comprised of wrist and hand dynamometry; dominant hand upper-extremity function measures (Jebsen Hand Function Test = JHFT, Minnesota Manual Dexterity Test = MMDT, and the Nine Hole Peg Test = NHPT); and activity of daily living with the Barthel Index.	**Limitations** There was no random allocation of participants to experimental & control groups, thus there is a high risk for selection bias. **Other information** Risk of Bias: Risk of Bias Assessment Using New Castle Ottawa Scale Selection:2/4 1) Representativeness: Institution based 2)Selection of non-exposed : From same group as exposed *

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Control group design with pre test post test for experimental group **Aim of the study** The purpose of the current study was to establish measurement reliability in adults with Cerebral Palsy (CP), and to examine the feasibility and outcomes of an upper extremity strength training program (three times per week for 90 min each time). **Study dates** Not mentioned **Source of funding** Not mentioned	Inclusion criteria for the strength intervention and the comparison groups were: (a) scores of less than 45 out of 100 points in the Barthel Index (BI); (b) CP with involvement of all four limbs to a moderate extent; (c) functional ambulation in a wheelchair; and (d) a degree of muscle tone and range of motion that allows the performance of manual movements with objects such as weights and bands **Exclusion criteria** Not described	(c) a stretching period of the major muscle groups for 10 min; and (d) after about an hour's rest, a second training period of the major muscle groups was performed lasting 30 min.			3)Ascertainment of exposure :Fidelity not measured 4) Demonstration that outcome of interest was not present at the start of study Baseline scores mentioned* Comparability 2/2 ** Controls for important factor, baseline characteristics comparable Outcome 3/3 *** 1) Blind/self-report Blinded evaluators 2) Was follow up enough Yes 3) Follow-up of Cohort: *
Full citation	**Sample size**	**Interventions**	**Details**	**Results**	**Limitations**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Lorentzen, J., Kirk, H., Fernandez-Lago, H., Frisk, R., Jensen, P., Nielsen, J. B., Randomized controlled clinical trial of the effect of gait training on muscle function and gait kinematics in adults with cerebral palsy, Developmental Medicine and Child Neurology, 58, 44, 2016 **Ref Id** 587088 **Country/ies where the study was carried out** Denmark **Study type** Randomised controlled trial **Aim of the study**	32 **Characteristics** Thirty-two adults diagnosed with CP (age 38.1 years SD 12, range 19–59 years; 14 men, 18 women) Training Group (n=16, Female=62.5%, Age: 37.4(2.6) 25% Hemiplegia, 62.5% Diplegia, 12.5% Quadriplegia, most affected leg Rt (44%), GMFCS 1=37.5%, 2=12.5%,3=50%) Surgical procedure: 2.3 +/- 2.9 Control Group: (n=16, Female=50%, Age: 38.5(12.5), Hemiplegia 12.5%, Diplegia 81.3%, Quadriplegia :6.2%, Most affected leg : 44% (?Rt), GMFCS	The training intervention consisted of 30 min daily uphill gait training for 6 weeks on a treadmill. Individualised training program +follow up visits by physiotherapists+maintainance of training log	After inclusion all participant were randomised to either the training group or intervention group. Block randomization was used to assure an equal amount of participants in each group. Sixteen participants were accordingly assigned to a training group and 16 participants to a non-training control group.	See Forest Plots	No information on inclusion/exclusion criteria **Other information** Risk of Bias Assessment: 1) Selection bias a) Random sequence generation: Unclear risk b) Allocation concealment: Unclear risk 2) Performance bias: Low risk 3) Detection bias: Low risk 4) Attrition bias: Low risk 5) Reporting bias: Unclear risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
To investigate if 30min of daily treadmill training with an incline for 6 weeks would reduce ankle joint stiffness and improve active range of movement in adults with cerebral palsy (CP). **Study dates** Not mentioned **Source of funding** None mentioned	1=18.8%, 2=37.5%,3=43.7%,), Surgical procedure: 2.0=/-1.8 Both groups: Antispastic medication: 12.5% **Inclusion criteria** Not described **Exclusion criteria** Not described				6) Other bias: No mention of dropouts Overall : High Risk
Full citation Maeland,S., Jahnsen,R., Opheim,A., Froslie,K.F., Moe-Nilssen,R., Stanghelle,J.K., No effect on gait function of progressive resistance exercise in adults with	**Sample size** 12 (PRE group=6, Control group=6) **Characteristics** Training group, Males-2, Females-4, Age=32-69 yrs, GMFCS 2- 4,GMFCS 3-2	**Interventions** PRE programme consisting of a 10-min warm-up, followed by SLP 1215 repetitions maximum (RM) in 4 sets, 3 days a week, for the first 2 weeks, progressing to 6RM in 4 sets, 3 days a week, for the following 6 weeks.	**Details** The participants were randomised into a training and a control group . The randomization was done by computerized generating of 12 Bernoulli trials (0s and 1s), using SPSS. Sealed, numbered envelopes with	**Results** See Forest Plots	**Limitations** Baseline differences in outcome measures between groups. **Other information** Risk of Bias Assessment: 1) Selection bias

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
cerebral palsy A single-blind randomised controlled trial, Advances in Physiotherapy, 11, 227-233, 2009 **Ref Id** 76077 **Country/ies where the study was carried out** Norway **Study type** Single-blind randomised controlled trial **Aim of the study** To examine the effects of a progressive resistance exercise (PRE) programme of seated leg press (SLP) on gait function in adults with spastic diplegic	Control group, Males-2 , Females-4, Age=27-65 yrs; GMFCS 2- 3,GMFCS 3-3 **Inclusion criteria** 1) above 18 years of age, 2) spastic diplegic CP 3) GMFCS level II or III 4)experiencing difficulties with walking, but able to walk for 6 min without or with minimal support from one person 5) being motivated for PRE. **Exclusion criteria** 1) having taken part in a specific strength training regime for the lower limbs during the past year		information about the treatment were prepared by the statistician.		a) Random sequence generation: Low risk b) Allocation concealment: Low risk 2) Performance bias: Low risk 3) Detection bias: Low risk 4) Attrition bias: Low risk 5) Reporting bias: Unclear risk 6) Other bias: Low Risk Overall : Low Risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
CP, Gross Motor Function Classification System (GMFCS) level II and III, who experience reduced walking ability. **Study dates** Not mentioned **Source of funding** Helse-Ost RHF (Eastern Norway Regional Health Authority)	2) having severe cognitive disorders				
Full citation Morgan, P., Murphy, A., Opheim, A., Pogrebnoy, D., Kravtsov, S., McGinley, J., The safety and feasibility of an intervention to improve balance dysfunction in ambulant adults with cerebral palsy: a	**Sample size** 17 **Characteristics** 17 participants (ten males, mean age 37 years, SD 11.3, range 19–53 years) **Inclusion criteria**	**Interventions** In both groups, participants attended an out-patient programme in small groups of three, on a Saturday afternoon, once weekly, for 1.5 hour sessions over an eight-week intervention period. An individualised structured home practice session (once a week, 30–60 minutes) was also prescribed for those in the	**Details** Following enrolment and baseline assessment, participants were randomised in blocks of six to either the intervention or control group. To conceal randomization, consecutively numbered sealed	**Results** See Forest Plots	**Limitations** 1) Small sample size 2) Only high functioning young/middle aged adults with cerebral palsy 3) Control group might have benefited from seated yoga

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
pilot randomised controlled trial, Clinical Rehabilitation, 29, 907-19, 2015 **Ref Id** 433649 **Country/ies where the study was carried out** Australia **Study type** assessor-blinded randomised controlled trial. **Aim of the study** To investigate the safety, feasibility and potential efficacy of balance training in adults with cerebral palsy **Study dates** Screening : January to October 2013	Inclusion criteria were: (i) a diagnosis of cerebral palsy (any subtype); (ii) aged ≥18 years; (iii) Gross Motor Function Classification System – Extended and Revised (GMFCS-E&R) Level I, II, or III (that is: able to walk independently or with an aid);17 (iv) able and willing to attend an eight- week therapy programme; and (v) medically permitted to participate in a balance training programme. In addition, in order to be able to provide informed consent, and actively participate within the programmes, eligible participants needed to have functional English language skills, and be classified as Level I	balance training group based on activities practiced within the weekly training sessions. The balance training was individually tailored according to an initial analysis of baseline impairments related to balance performance, as indicated by the Balance Evaluation Systems test. The balance training included practice of anticipatory and reactive dynamic balance strategies in standing and stepping, and dynamic gait activities, tailored to improve walking ability and safety. Progressive resistance strengthening exercises were incorporated into the balance training programme and targeted major muscle groups of the lower limbs involved in balance control, such as ankle dorsiflexors and plantarflexors, knee extensors, hip extensors, and abductors, all carried out in functional training positions. The control group programme included seated activities, such as guided relaxation, meditation,	envelopes were prepared in advance and opened in sequence by an independent advisor not involved in recruitment. A maximum of three participants were enrolled at a time in either balance or control groups in order to optimize the individual tailoring of the training programme and provision of close supervision. Four experienced physiotherapists and two allied health assistants (exercise physiologists) were trained to deliver the interventions. Clinical outcome measures were evaluated at baseline (Week 0), following intervention (Week 8), and 4 months after programme completion (Week 24).		**Other information** Risk of Bias Assessment: 1) Selection bias a) Random sequence generation: Low risk b) Allocation concealment: Low risk 2) Performance bias: High risk 3) Detection bias: Low risk 4) Attrition bias: Low risk 5) Reporting bias: Unclear risk Overall : High Risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Source of funding This study has been funded by a 2013 Lions John Cockayne Memorial Trust Fund.	or II on the Communication Function System for individuals with cerebral palsy **Exclusion criteria**	mindfulness and seated yoga, and Tai Chi. No activities relating to walking or standing balance were included in the programme for the control group.	Assessments were completed in an outpatient department by an experienced physiotherapist blinded to group allocation.		
Full citation Schroeder,K., Hauck,C., Wiedenhofer,B., Braatz,F., Aldinger,P.R., Long-term results of hip arthroplasty in ambulatory patients with cerebral palsy, International Orthopaedics, 34, 335-339, 2010 **Ref Id** 133935 **Country/ies where the study was carried out** Germany	**Sample size** 16 **Characteristics** Total number=16, Age: 42±8 years (range 32–58) Male=6, Female=10 Spastic Quadriplegia=8, Hemiplegia=3, Diplegia=4, Unclassified=1 **Inclusion criteria** Painful osteoarthritis with severely limited functional ability.	**Interventions** Hip replacement using different combination of implants (cemented/uncemented)+ Soft tissue releases(in case of contracture)/Brace(if needed) + Physiotherapy	**Details** Lost to follow up=2, 1 patient died. Analysis of 13 patients for most outcomes. Follow-up of 10±6 years (range 2–18 years). Patients were either interviewed themselves (n=5) or questions were answered by carers (family or nurses) n=8).Immediately after operation anteriorposterior radiographs	**Results** Participation: Walking : Free walking pre & post op=2, walking aids pre and post op=7, non ambulatory preop, free walking post op=3, free walking preop, walking aids post op=2 Independence: Improvement in hygiene care	**Limitations** 1) Small sample Size 2) Telephonic interview 3) Lack of uniformity in implants **Other information** Risk of Bias assessment using Checklist for Interrupted times series Protection against secular changes - done Data were analysed appropriately - not done

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study type Before-and-after Single group **Aim of the study** To study the long-term results of hip arthroplasty in ambulatory patients with cerebral palsy **Study dates** 1988-2004 **Source of funding** Not reported	Others not described **Exclusion criteria** Not described		of the hip joint were taken and evaluated.	postpopratively= 7, No problems preop and postop=4, No improvement in hygiene care =2 Problems with hygiene care postop=1	Sample size calculation performed - not done Shape of the intervention effect was specified - not done Protection against detection bias: Intervention unlikely to affect data collection - done Protection against detection bias: Blinded assessment of primary outcome(s) - not done
Full citation Taylor, N. F., Dodd, K. J., Baker, R. J., Willoughby, K., Thomason, P., Graham, H. K., Progressive resistance training	**Sample size** 48 **Characteristics** Number = 48, Diagnosis=Spastic diplegic CP , Gender: 26 males, 22	**Interventions** Intervention Duration & Frequency :Twice a week for 12 weeks Intervention Description: Progressive resistance training programme in a community gymnasium on weights	**Details** Separate randomization procedure for each stratum (GMFCS levels II and III) was done using permuted blocks. An	**Results** See Forest Plots	**Limitations** 1) Amount of other physical activity done by the subjects was not measured 2) Target sample size not achieved

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
and mobility-related function in young people with cerebral palsy: A randomised controlled trial, Developmental Medicine and Child Neurology, 55, 806-812, 2013 **Ref Id** 587561 **Country/ies where the study was carried out** Australia **Study type** Randomised controlled trial **Aim of the study** To investigate whether individualized resistance training improves the physical mobility of young people with cerebral palsy (CP).	females, Age(Mean)= 18y 1mo, SD= 1y 11mo, Classification: level II or III on the Gross Motor Function Classification **Inclusion criteria** 1) spastic diplegic CP 2) Aged between 14 years and 22 years 3) Classified as level II or III on the Gross Motor Function Classification System (GMFCS) 4) be able to follow simple instructions. **Exclusion criteria** 1) Participation in a strength training programme in the previous 6 months	machines either singly or in pairs under the supervision of a physiotherapist. 10 to 12 repetitions of each exercise, with a 2-minute break between each set. Participants were instructed that they should feel as though they had worked 'hard', scoring at least a 5 on the 0 to 10 category of the Borg Perceived Exertion Scale, which was evaluated at the end of each session. Each participant had a logbook detailing each exercise, the weight lifted, the number of repetitions, the number of sets completed, and the details of any injuries.	independent researcher generated a block allocation sequence for each stratum by drawing pieces of paper from a sealed container and then sealing assignments in sequentially numbered opaque envelopes. The research coordinator allocated participants after enrolment and baseline testing. Participants allocated to the experimental group completed a twice-weekly, 12-week progressive resistance training programme in a community gymnasium close to home. Outcome measures were evaluated at baseline, after the intervention (week 12), and after a further 12 weeks (week 24). Assessments were completed in a hospital		**Other information** Risk of Bias Assessment: 1) Selection Bias a) Random sequence generation (selection bias): Low risk b) Allocation concealment (selection bias): Low risk 2) Blinding of participants and personnel (performance bias): Low risk 3) Blinding of outcome assessment (detection bias): High risk 4) Incomplete outcome data (attrition bias): Low risk

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported **Source of funding** This trial was supported financially by a grant from the National Health and Medical Research Council of Australia (ID 487321).	2) Undergone single event multi-level orthopaedic surgery in the previous 2 years, or 3) Contractures of more than 20° at the hip and knees		gait laboratory by an assessor blinded to group allocation		5) Selective reporting (reporting bias): Unclear risk 6) Other bias: None Overall: High risk
Full citation Houdek, M. T., Watts, C. D., Wyles, C. C., Trousdale, R. T., Milbrandt, T. A., Taunton, M. J., Total Hip Arthroplasty in Patients with Cerebral Palsy: A Cohort Study Matched to Patients with Osteoarthritis, The Journal of bone and joint surgery,	**Sample size** 39 **Characteristics** No. of participants with CP group= 39, Number of participants in osteoarthritis group= 78; Mean age= 49 (Range: 21 to 74 years); Total males : 26 in CP group, 52 in osteoarthritis group; Total females: 13 in CP group, 26	**Interventions** Total hip arthroplasty surgery: The surgical procedures were performed by high volume adult reconstruction subspeciality surgeons by their preferred surgical approach. Surgeries were augmented with a tendon release (n=7), or psoas(n=2), acetabular constraint(dual mobility, n=5) or lipped liner (n=2) and acetabular structural support (femoral head augmentation ,n=4).	**Details** Patients with cerebral palsy were matched randomly in 1: 2 ratio to a group of patients undergoing total hip arthroplasty for osteoarthritis over the same time period. All patients were followed longitudinally to the time of implant revision or death. Mean follow up : 7 years (range, 2 to 20 years)	**Results** See forest plots	**Limitations** 1) Retrospective collection of data 2) Small sample size 3) Use of Harris hip scores for people with cerebral palsy is not validated **Other information** Risk of Bias: Risk of Bias Assessment Using

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
American volume. 99, 488-493, 2017 **Ref Id** 635779 **Country/ies where the study was carried out** United States **Study type** Retrospective cohort study with control group **Aim of the study** To compare the outcomes of total hip arthroplasty in patients with cerebral palsy to matched patients with a diagnosis of osteoarthritis **Study dates** 1990 to 2013 **Source of funding**	in osteoarthritis group at the time of surgical procedure **Inclusion criteria** Those undergoing primary total hip arthroplasty for : radiographic evidence of hip osteoarthritis, failure of non operative treatment for hip pain, the ability to walk either independently or with use of gait aids, and correctable hip contractures **Exclusion criteria** Not obtained 2 years of clinical follow-up				New Castle Ottawa Scale Selection:2/4 1) Representativeness: Institution based 2)Selection of non exposed : From same institution as exposed * 3)Ascertainment of exposure :Fidelity not measured 4) Demonstration that outcome of interest was not present at the start of study Baseline scores mentioned* Comparability 2/2 ** Controls for important factor, baseline characteristics comparable Outcome 2/3 **

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
None					1) Blind/self report : Blinding not possible 2) Was follow up enough Yes 3) Follow up of Cohort : Yes
Full citation Teixeira-Machado, L., Azevedo-Santos, I., DeSantana, J. M., Dance Improves Functionality and Psychosocial Adjustment in Cerebral Palsy: A Randomised Controlled Clinical Trial, American journal of physical medicine & rehabilitation, 96, 424-429, 2017 **Ref Id** 675601	**Sample size** 26 **Characteristics** Dance group (n=13), Mean age: 18 (3.46), Male=6, Female=7; Kinesiotherapy group (n=13), Mean age: 17.07(2.36), Male=5, Female=8; **Inclusion criteria** 1) Having a diagnosis of cerebral palsy 2) Age between 15 to 29 years	**Interventions** Dance class based on Feldenkrais, Horton, Graham and Laban/Bartenieff concepts, 1 hour lessons , twice a week for 3 months.	**Details** The control group performed traditional kinesiotherapy exercises using Bobath and Kabat methods and Frenkel and proprioception exercises during the same time as dance lessons.	**Results** See forest plots	**Limitations** Small sample size **Other information** Risk of Bias Assessment: 1) Selection Bias a) Random sequence generation (selection bias) :Low risk b) Allocation concealment (selection bias) :Unclear risk 2) Blinding of participants and personnel

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out Brazil **Study type** Randomised controlled trial **Aim of the study** To study the effect of dance on functionality and psychosocial adjustment of young subjects with cerebral palsy (CP) **Study dates** Not mentioned **Source of funding** Not mentioned	3) increased muscle tone 4) No physical activity during the duration of study 5) No cardiopathy or neoplasy **Exclusion criteria** Cognitive & psychiatric disturbances				(performance bias):Low risk 3) Blinding of outcome assessment (detection bias): High risk 4) Incomplete outcome data (attrition bias):Low risk 5) Selective reporting (reporting bias): Unclear risk 6) Other bias: None Overall: High risk

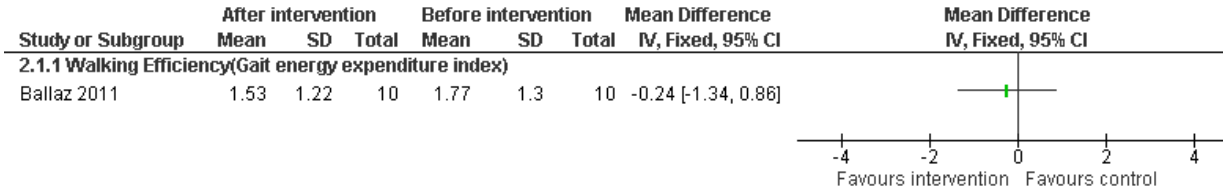
Appendix E – Forest plots

Forest plots for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

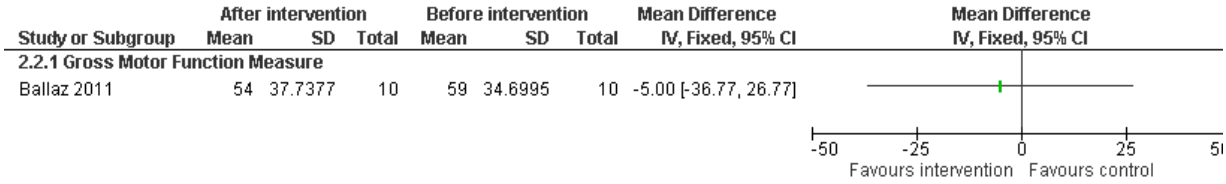
Comparison 1: Physical activity intervention, before versus after

Figure 2: Participation (walking efficiency) at post-test following physical activity intervention versus before



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

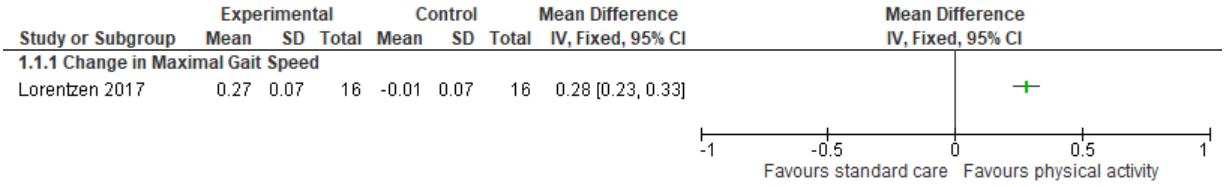
Figure 3: Physical function (Gross Motor Function Measure) at post-test following physical activity intervention versus before



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

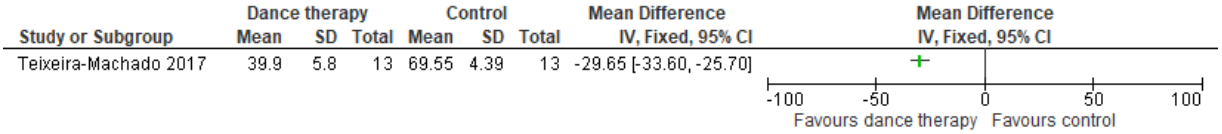
Comparison 2: Physical activity interventions versus standard care

Figure 4: Participation (maximal gait speed) at post-test following physical activity intervention versus standard care



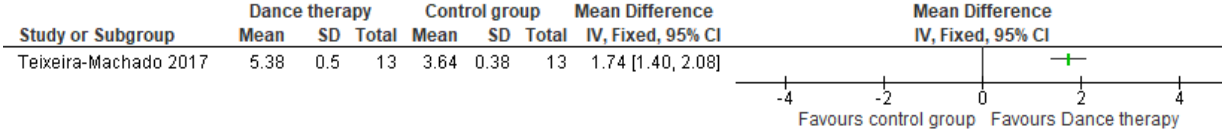
CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

Figure 5: Physical function at post-test following physical activity intervention versus standard care



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

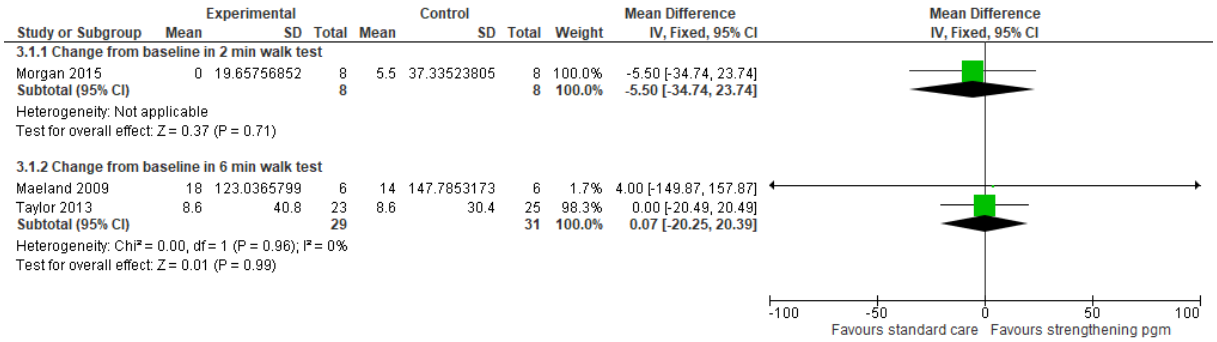
Figure 6: Independence at post-test following physical activity intervention versus standard care



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

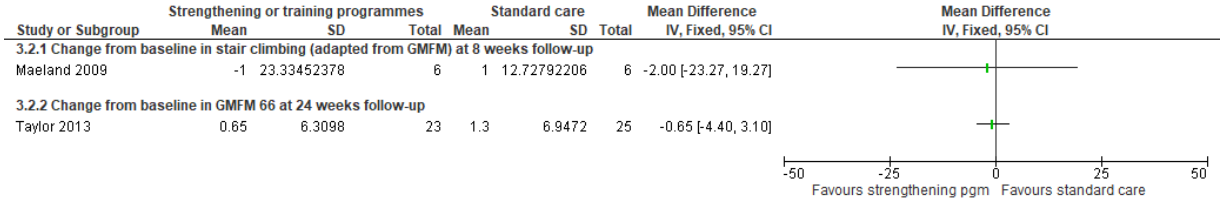
Comparison 3: Strengthening or training programmes versus standard care

Figure 7: Participation at 8 to 12 weeks follow-up after strengthening or training programmes versus standard care



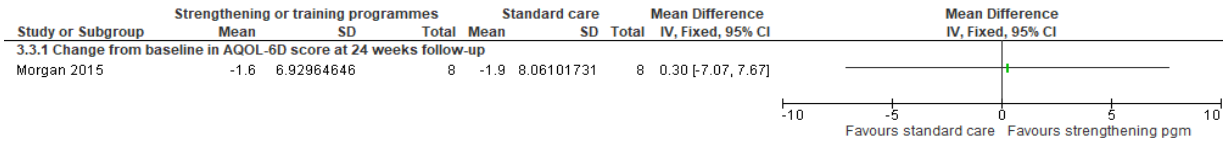
CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 8: Physical function at 8 to 12 weeks follow-up after strengthening or training programmes versus standard care



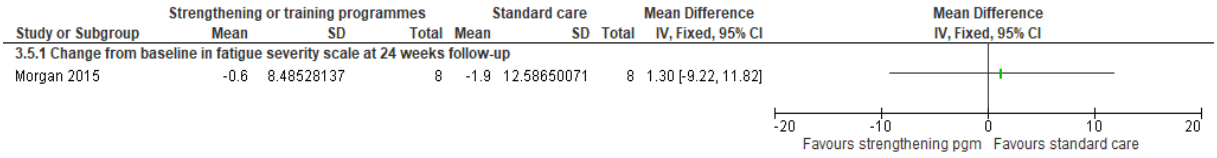
CI: Confidence interval; GMFM: Gross motor function measure; IV: Inverse variance; pgm: programme, SD: Standard deviation

Figure 9: Health related quality of life at 24 weeks follow-up after strengthening or training programmes versus standard care



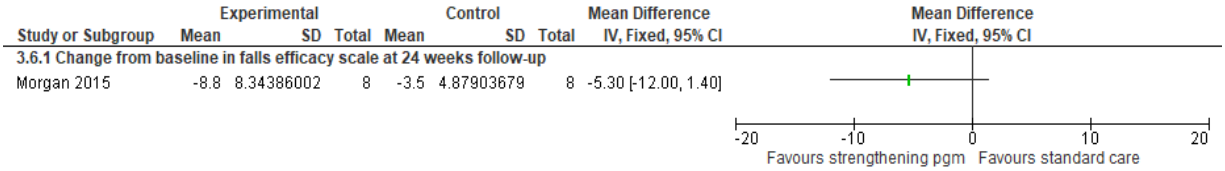
AQOL-6D: Assessment of Quality of life instrument 6D; CI: Confidence interval; GMFM: Gross motor function measure; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 10: Fatigue at 24 weeks follow-up after strengthening or training programmes versus standard care



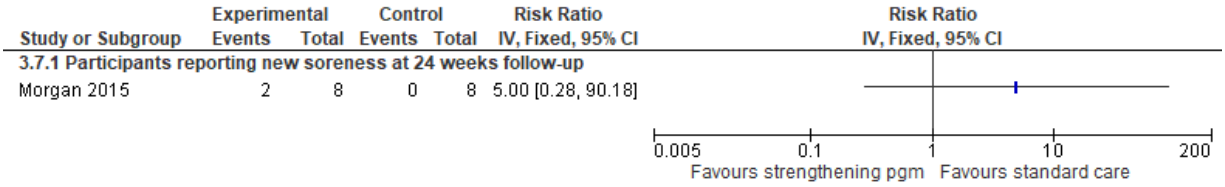
CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 11: Frequency of falls at 24 weeks follow-up after strengthening or training programmes versus standard care



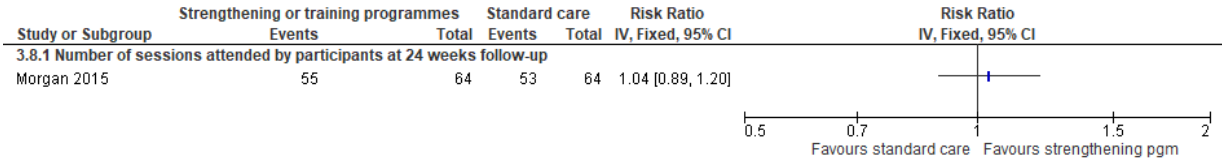
CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 12: Complications of treatment at 24 weeks follow-up after strengthening or training programmes versus standard care



CI: Confidence interval; IV: Inverse variance; pgm: programme;SD: Standard deviation

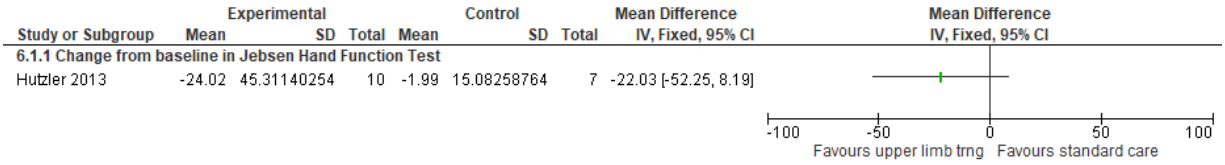
Figure 13: Adherence to treatment at 24 weeks follow-up after strengthening or training programmes versus standard care



CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

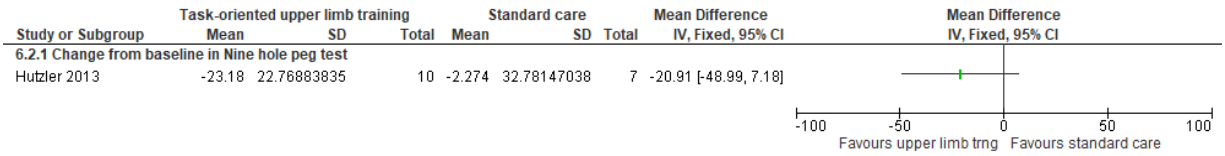
Comparison 4: Task oriented upper limb training versus standard care

Figure 14: Participation at post-test following task oriented upper limb training versus standard care



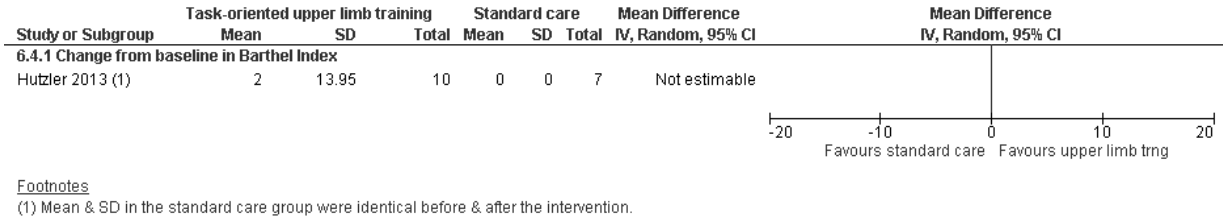
CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 15: Physical function at post-test following task oriented upper limb training versus standard care



CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

Figure 16: Independence at post-test following task oriented upper limb training versus standard care

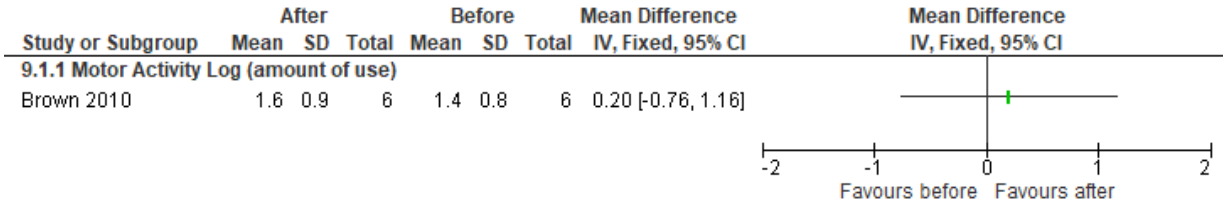


Footnotes
(1) Mean & SD in the standard care group were identical before & after the intervention.

CI: Confidence interval; IV: Inverse variance; pgm: programme; SD: Standard deviation

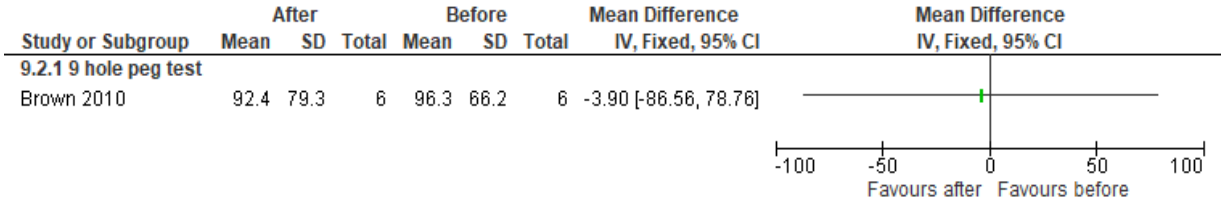
Comparison 5: Task oriented upper limb training, before versus after

Figure 17: Participation at post-test following task oriented upper limb training versus before



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

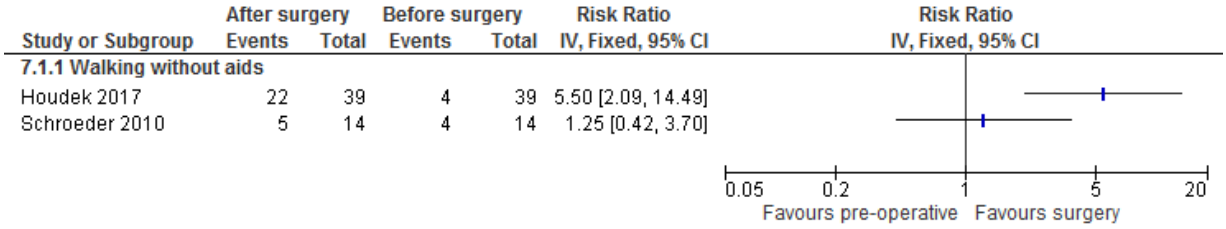
Figure 18: Physical function at post-test following task oriented upper limb training versus before



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

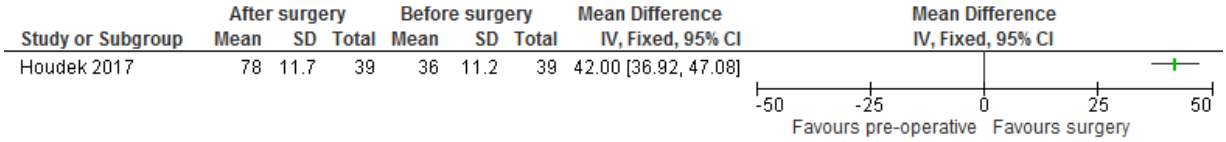
Comparison 6: Orthopaedic surgery, pre versus post-operative

Figure 19: Participation following orthopaedic surgery, pre versus post-operative outcomes



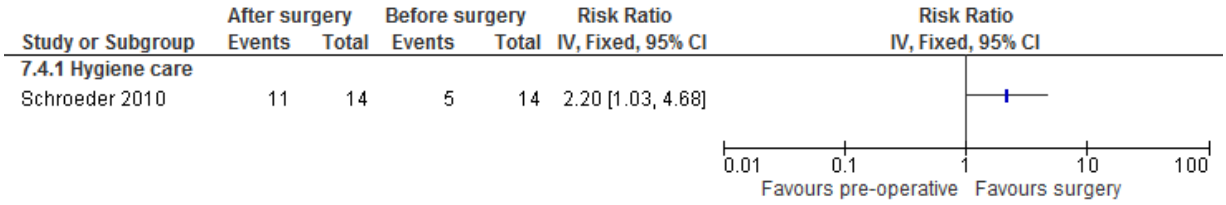
CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

Figure 20: Physical function following orthopaedic surgery, pre versus post-operative outcomes



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

Figure 21: Independence following orthopaedic surgery, pre versus post-operative outcomes



CI: Confidence interval; IV: Inverse variance; SD: Standard deviation

Appendix F – GRADE tables

GRADE tables for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Table 14: Clinical evidence profile: Comparison 1: Physical activity intervention, before versus after outcomes

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After Physical Activity intervention	Before	Relative (95% CI)	Absolute	Quality	Importance
Participation (measured with: Walking efficiency(Gait energy expenditure index); Better indicated by lower values)[1]												
1	observational studies	Serious[2]	No serious inconsistency	No serious indirectness	Serious[3]	None	10[5]	10[5]	-	MD 0.24 lower (1.3 lower to 0.82 higher)	VERY LOW	CRITICAL
Physical function (measured with: Gross Motor Function Measure (GMFM) D & E; Better indicated by lower values)[4]												
1	observational studies	Serious[2]	No serious inconsistency	No serious indirectness	Serious[3]	None	10[5]	10[5]	-	MD 5.00 lower (35.31 lower to 25.31 higher)	VERY LOW	CRITICAL
Health related quality of life - not reported												
-	-	-	-	-	-	-	-	-	-	-	-	CRITICAL
Independence - not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Fatigue- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Frequency of falls- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Complications of treatment- not reported												

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After Physical Activity intervention	Before	Relative (95% CI)	Absolute	Quality	Importance
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Adherence- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; GMFM: gross motor function measure; MD: Mean difference; SD: standard deviation;

1. Gait energy expenditure index: Lower values indicate better gait efficiency

2. Downgraded for serious risk of bias due to lack of blinding during assessment

3. Downgraded for serious imprecision as confidence interval includes one MID threshold

4. Higher GMFM scores indicate better motor function

5 10/12 participants completed the training intervention

Table 15: Clinical evidence profile: Comparison 2: Physical activity interventions versus standard care

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Physical activity interventions	Standard care	Relative (95% CI)	Absolute		
Participation (Follow-up: Post-test at 3 months; measured with: Change in maximal gait speed; Better indicated by higher values)[1]												
1	randomised trials	Serious[2]	No serious inconsistency	No serious indirectness	Serious[3]	None	16	16	-	MD 3.90 higher (2.67 to 5.13 higher)	LOW	CRITICAL
Physical function (Follow-up: Post-test at 3 months; measured with: ICF total score; Better indicated by lower values)												
1	randomised trials	Serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	None	13	13	-	MD 29.65 lower (33.6 to 25.7 lower)	LOW	CRITICAL
Health related quality of life- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	CRITICAL
Independence (Follow-up: Post-test at 3 months; measured with: FIM; Better indicated by higher values)												
1	randomised trials	Serious[4]	No serious inconsistency	No serious indirectness	Serious[3]	None	13	13	-	MD 1.74 higher (1.4 to 2.08 higher)	LOW	IMPORTANT
Fatigue- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Frequency of falls- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Complications of treatment- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Adherence- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT

CI: confidence interval; FIM: Functional independence measure; GRADE: grading of recommendations assessment development and evaluation; ICF: International classification of functioning; NGA: National Guideline Alliance; MD: Mean difference; RCT: randomised controlled trial; SD: standard deviation
1. Higher mean change in maximal gait speed indicates better participation; change in maximal gait speed calculated by NGA team
2. Downgraded for serious risk of bias as information on withdrawal/dropouts is not reported for control group
3. Downgraded for serious imprecision as number of participants <400
4. Downgraded for serious risk of bias due to lack of blinding of assessors

Table 16: Clinical evidence profile: Comparison 3: Strengthening or training programmes versus standard care

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Strengthening or training programmes	Standard care	Relative (95% CI)	Absolute	Quality	Importance
Participation - Change from baseline to 24 weeks in 2 min walk test (Better indicated by higher values)[1]												
1	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	7[12]	8	-	MD 5.5 lower (34.74 lower to 23.74 higher)	LOW	CRITICAL
Participation (measured with: Change in baseline in 6 min walk test; Better indicated by higher values)[4]												
2	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	29	31	-	MD 0.07 higher (20.25 lower to 20.39 higher)	LOW	CRITICAL
Physical function (measured with: Change from baseline in Stair Climbing (adapted from GMFM); Better indicated by lower values)[5]												
1	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	6	6	-	MD 2.00 lower (23.27 lower to 19.27 higher)	LOW	CRITICAL
Physical function (measured with: Change from Baseline in GMFM 66; Better indicated by higher values)[6]												
1	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	23	25	-	MD 0.65 lower (4.4 lower to 3.1 higher)	LOW	CRITICAL
HrQOL (measured with: Change from baseline to 24 weeks in AQOL-6D (Assessment of Quality of Life Instrument-6D); Better indicated by higher values)[7]												
1	randomised trials	Serious[8]	No serious inconsistency	No serious indirectness	Very serious[3]	None	7[12]	8	-	MD 0.30 higher (7.07 lower to 7.67 higher)	VERY LOW	CRITICAL
Independence - not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Fatigue (measured with: Change from baseline to 24 weeks in Fatigue Severity Scale; Better indicated by lower values)[9]												

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Strengthening or training programmes	Standard care	Relative (95% CI)	Absolute		
1	randomised trials	Serious[8]	No serious inconsistency	No serious indirectness	Very serious[3]	None	7[12]	8	-	MD 1.30 higher (9.22 lower to 11.82 higher)	VERY LOW	IMPORTANT
Falls (measured with: Change from baseline to 24 weeks in Falls Efficacy Scale; Better indicated by lower values)[10]												
1	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	7[12]	8	-	MD 5.3 lower (12 lower to 1.4 higher)	VERY LOW	IMPORTANT
Complications of treatment (measured with: Participants reporting new soreness; Better indicated by lower values)[11]												
1	randomised trials	No serious risk of bias	No serious inconsistency	No serious indirectness	Very serious[3]	None	2/8 (25%)	0/8 (0%)	RR 5.00 (0.28 to 90.18)	-	LOW	IMPORTANT
Adherence to treatment (measured with: Number of sessions attended)												
1	randomised trials	Serious[2]	No serious inconsistency	No serious indirectness	Serious[11]	None	55/64 (85.9%)	53/64 (82.8%)	RR 1.04 (0.89 to 1.20)	31 more per 1000 (from 126 fewer to 113 more)	LOW	IMPORTANT

AQOL-6D: Assessment of Quality of Life Instrument-6D; CI: confidence interval; GMFM: gross motor function measure; GRADE: grading of recommendations assessment development and evaluation; HrQOL: health related quality of life; MD: mean difference; RR: risk ratio; NGA: National Guideline Alliance; RCT: randomised controlled trial; SD: standard deviation

1. Higher change from baseline in 2 minute walk test indicates better participation; change from baseline scores calculated by NGA team
2. Downgraded for serious risk of bias due to unit of analysis issues – there were 8 observations for this outcome from each participant which are likely to be correlated
3. Downgraded for very serious imprecision due as confidence interval includes both MID thresholds
4. Change from baseline in 6 minute walk test: Higher value indicates better participation
5. Change from baseline in stair climbing: Higher value indicates better motor function
6. Change from baseline in GMFM 66: higher value indicates better motor function
7. Change in baseline in HrQOL: higher value indicates better health related quality of life
8. Downgraded for serious risk of bias due to lack of blinding in this subjective outcome
9. Change from baseline in fatigue severity scale: Lower value indicates better outcome
10. Change from baseline in falls efficacy scale: lower value indicates better outcome
11. Downgraded for serious imprecision due to number of events < 300
12. Outcome data at week 24 were available for 15/17 participants.1 participant was lost to follow-up and 1 withdrew (both in the intervention group)

Table 17: Clinical evidence profile: Comparison 4: Task-oriented upper limb training versus standard care

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Task-oriented upper limb training	Standard care	Relative (95% CI)	Absolute	Quality	Importance
Participation (measured with: Change from baseline in Jebsen Hand Function Test; Better indicated by lower values)[1]												
1	observational studies	Serious[2]	no serious inconsistency	no serious indirectness	Very serious[6]	none	10	7	-	MD 22.03 lower (52.25 lower to 8.19 higher)	VERY LOW	CRITICAL
Physical function (measured with: Change from baseline in Nine hole peg test; Better indicated by lower values)[4]												
1	observational studies	Serious[2]	no serious inconsistency	no serious indirectness	Serious[3]	none	10	7	-	MD 20.91 lower (48.99 lower to 7.18 higher)	VERY LOW	CRITICAL
HrQOL - not reported												
-	-	-	-	-	-	-	-	-	-	-	-	CRITICAL
Independence (measured with: Change from baseline in Barthel Index; Better indicated by higher values)[5]												
1	observational studies	Serious[2]	no serious inconsistency	no serious indirectness	Very serious[7]	none	10	7	-	Not estimable[7]	VERY LOW	IMPORTANT
Fatigue- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Frequency of falls- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Complications of treatment- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Adherence- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; MD: mean difference; SD: standard deviation
1. Jebsen hand function test: Lower score indicates greater function. Change from baseline values calculated by NGA team
2. Downgraded for serious risk of selection bias, as the baseline characteristics of intervention and control groups are not reported (and no adjustments were made for confounders) and it is unclear how they were selected
3. Downgraded for serious imprecision as confidence interval includes one MID threshold
4. Nine hole peg test: lower scores indicate better function. Change from baseline values calculated by NGA team.

5. Barthel Index: Higher scores indicate more independence. Change from baseline values calculated by NGA team.
6. Downgraded for very serious imprecision as confidence interval includes both MID thresholds.
7. Mean and standard deviation of change from baseline in the standard care group were both zero, so mean difference could not be estimated.

Table 18: Clinical evidence profile: Comparison 5: Task-oriented upper limb training, before versus after outcomes

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After Upper limb training	Before Upper limb training	Relative (95% CI)	Absolute		
Participation - Motor Activity Log (amount of use) (Better indicated by higher values)												
1	observational studies	Serious[1]	no serious inconsistency	no serious indirectness	Very serious[2]	none	6	6	-	MD 0.20 higher (0.76 lower to 1.16 higher)	VERY LOW	CRITICAL
Physical Function (measured with: 9 hole peg test; Better indicated by lower values)												
1	observational studies	Serious[1]	no serious inconsistency	no serious indirectness	Very serious[2]	none	6	6	-	MD 3.90 lower (86.56 lower to 78.76 higher)	VERY LOW	CRITICAL
HrQOL - not reported												
-	-	-	-	-	-	-	-	-	-	-	-	CRITICAL
Independence (measured with: Change from baseline in Barthel Index; Better indicated by higher values)[5]												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Fatigue- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Frequency of falls- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Complications of treatment- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Adherence- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT

CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; MD: mean difference; SD: standard deviation

1. Downgraded for serious risk of bias due to self-reporting of outcomes
2. Downgraded for very serious imprecision as the confidence interval included both MID thresholds

Table 19: Clinical evidence profile: Comparison 6: Orthopaedic surgery, pre- versus post-operative outcomes

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After orthopaedic surgery	Before orthopaedic surgery	Relative (95% CI)	Absolute	Quality	Importance
Participation (Follow-up: mean 7 to 10 years; measured with :participants walking without aids; Better indicated by higher values)												
2	observational studies	Very serious[1,3]	Serious[2]	No serious indirectness	No serious imprecision	None	53	53	RR ranged from 1.25 (0.42 to 3.70) to 5.50 (2.09 to 14.49)	-	VERY LOW	CRITICAL
Physical function (Follow-up: mean 7 years; measured with :Harris hip score; Better indicated by higher values)												
1	observational studies	Serious[3]	No serious inconsistency	No serious indirectness	No serious imprecision	None	39	39	MD 42.0 (36.92 to 47.08 higher)	-	VERY LOW	CRITICAL
Health related quality of life- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	CRITICAL
Independence(Follow-up: mean 10 years; measured with: participants with hygiene care; Better indicated by higher values)												
1	observational studies	Very serious[1]	No serious inconsistency	No serious indirectness	No serious imprecision	None	14	14	RR 2.20 (1.03 to 4.68)	-	VERY LOW	IMPORTANT
Fatigue- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Frequency of falls- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Complications of treatment- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT
Adherence- not reported												
-	-	-	-	-	-	-	-	-	-	-	-	IMPORTANT

SD: standard deviation; CI: confidence interval; GRADE: grading of recommendations assessment development and evaluation; RR: Risk ratio
1. Downgraded for very serious risk of bias due to selection bias and outcome assessment bias
2. Downgraded for serious inconsistency: one of the studies showed a clinically significant benefit with orthopaedic surgery whereas the other did not
3. Downgraded for serious risk of bias due to retrospective collection of data

Appendix G – Economic evidence study selection

Economic evidence study selection for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

No economic evidence was identified for this review.

Appendix H – Economic evidence tables

Economic evidence tables for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

No economic evidence was identified for this review.

Appendix I – Health economic evidence profiles

Health economic evidence profiles for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

No economic evidence was identified for this review.

Appendix J – Health economic analysis

Health economic analysis for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

No economic analysis was included in this review.

Appendix K – Excluded studies

Clinical and economic lists of excluded studies for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

Clinical studies

Table 20: Excluded clinical studies for interventions for maintaining physical function

Excluded studies – D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy? • **Physical activity** • **Strengthening programmes or training** • **Orthotics** • **Task-oriented upper limb training** • **Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).**	
Study	**Reason for Exclusion**
Abel,M.F., Damiano,D.L., Pannunzio,M., Bush,J., Muscle-tendon surgery in diplegic cerebral palsy: functional and mechanical changes, Journal of Pediatric Orthopedics, 19, 366-375, 1999	The mean age at surgery was 8.7 years
Ahmed, G. S., Flexor carpi ulnaris transfer to improve function and cosmesis of hand in patients with cerebral palsy, Pakistan Journal of Medical Sciences, 23, 242-244, 2007	Age group of participants is 7.5 years
Bania, T, Dodd, Kj, Taylor, N, Habitual physical activity can be increased in people with cerebral palsy: a systematic review (Provisional abstract), Clinical Rehabilitation, 25, 303-15, 2011	RCTs for paediatric age
Bania, Ta, Dodd, Kj, Baker, Rj, Graham, Hk, Taylor, Nf, The effects of progressive resistance training on daily physical activity in young people with cerebral palsy: a randomised controlled trial, Disability and Rehabilitation, 38, 620-6, 2016	This evidence has already been used in Spasticity Under 19 Guideline
Boldingh, E. J. K., Jacobs-Van Der Bruggen, M. A. M., Bos, C. F. A., Lankhorst, G. J., Bouter, L. M., Radiographic hip disorders and associated complications in severe cerebral palsy, Journal of Pediatric Orthopaedics Part B, 16, 31-34, 2007	Cross sectional study
Boldingh, E. J., Bouwhuis, C. B., van der Heijden-Maessen, H. C., Bos, C. F., Lankhorst, G. J., Palliative hip surgery in severe cerebral palsy: a systematic review, Journal of Pediatric Orthopaedics, Part B, 23, 86-92, 2014	Outcomes mentioned in protocol not reported
Boyd, R. N., Mitchell, L. E., James, S. T., Ziviani, J., Sakzewski, L., Smith, A., Rose, S., Cunnington, R., Whittingham, K., Ware, R. S., Comans, T. A., Scuffham, P. A., Move it to improve it (Mitii): Study	Protocol

protocol of a randomised controlled trial of a novel web-based multimodal training program for children and adolescents with cerebral palsy, BMJ Open, 3, 2013	
Brunton, L. K., Bartlett, D. J., Description of Exercise Participation of Adolescents With Cerebral Palsy Across a 4-Year Period, Pediatric Physical Therapy, 22, 180-187, 2010	Mean age was 14.7 years
Bulman, W. A., Dormans, J. P., Ecker, M. L., Drummond, D. S., Posterior spinal fusion for scoliosis in patients with cerebral palsy: a comparison of Luque rod and Unit Rod instrumentation, Journal of Pediatric Orthopedics, 16, 314-23, 1996	Mean age 14.5 years
Buly, R. L., Huo, M., Root, L., Binzer, T., Wilson Jr, P. D., Total hip arthroplasty in cerebral palsy: Long-term follow-up results, Clinical Orthopaedics and Related Research, 148-153, 1993	No comparison group
Carlon, S. L., Taylor, N. F., Dodd, K. J., Shields, N., Differences in habitual physical activity levels of young people with cerebral palsy and their typically developing peers: a systematic review, Disability and rehabilitation, 35, 647-655, 2013	Mean age group in all studies: 5- 18 years
Cassidy,C., Craig,C.L., Perry,A., Karlin,L.I., Goldberg,M.J., A reassessment of spinal stabilization in severe cerebral palsy, Journal of Pediatric Orthopaedics, 14, 731-739, 1994	Borderline age group. Main outcome measure is pain, pulmonary medication utilization, which is not included in protocol
Chambers, H., Lauer, A., Kaufman, K., Cardelia, J. M., Sutherland, D., Prediction of outcome after rectus femoris surgery in cerebral palsy: the role of cocontraction of the rectus femoris and vastus lateralis, Journal of Pediatric Orthopedics, 18, 703-11, 1998	Mixed population. Average age 9 years and 4 months
Claassen, A. A. O. M., Gorter, J. W., Stewart, D., Verschuren, O., Galuppi, B. E., Shimmell, L. J., Becoming and staying physically active in adolescents with cerebral palsy: Protocol of a qualitative study of facilitators and barriers to physical activity, BMC Pediatrics, 11 (no pagination), 2011	Research Protocol
Claridge, E. A., McPhee, P. G., Timmons, B. W., Martin Ginis, K. A., Macdonald, M. J., Gorter, J. W., Quantification of Physical Activity and Sedentary Time in Adults with Cerebral Palsy, Medicine and Science in Sports and Exercise, 47, 1719-1726, 2015	No intervention. No control group
Cleary, S. L., Taylor, N. F., Dodd, K. J., Shields, N., An aerobic exercise program for young people with cerebral palsy in specialist schools: A phase I randomized controlled trial, Developmental Neurorehabilitation, 20, 331-338, 2017	Age group less than 16 years
Conchar, L., Bantjes, J., Swartz, L., Derman, W., Barriers and facilitators to participation in physical activity: The experiences of a group of South African adolescents with cerebral palsy, Journal of Health Psychology, 21, 152-63, 2016	Qualitative study
Dahlin, L. B., Komoto-Tufvesson, Y., Salgeback, S., Surgery of the spastic hand in cerebral palsy. Improvement in stereognosis and hand function after surgery, Journal of Hand Surgery - British Volume, 23, 334-9, 1998	Age less than 16 years
Debuse,D., Gibb,C., Chandler,C., Effects of hippotherapy on people with cerebral palsy from the users' perspective: a qualitative study, Physiotherapy Theory and Practice, 25, 174-192, 2009	Qualitative study

Dicianno,B.E., Mahajan,H., Guirand,A.S., Cooper,R.A., Virtual electric power wheelchair driving performance of individuals with spastic cerebral palsy, American Journal of Physical Medicine and Rehabilitation, 91, 823-830, 2012	Comparison of CP Vs Non CP , but also isometric joystick vs sensing joystick
Dickin,D.C., Faust,K.A., Wang,H., Frame,J., The acute effects of whole-body vibration on gait parameters in adults with cerebral palsy, Journal of Musculoskeletal Neuronal Interactions, 13, 19-26, 2013	Before-and-after study. Sample size 8
Dietz,F.R., Albright,J.C., Dolan,L., Medium-term follow-up of Achilles tendon lengthening in the treatment of ankle equinus in cerebral palsy, Iowa Orthopaedic Journal, 26, 27-32, 2006	Average : 7 years
Dreher, T., Wenz, W., Tendon transfers for the balancing of hind and mid-foot deformities in adults and children, Techniques in Foot and Ankle Surgery, 8, 178-189, 2009	Case series
Frisch, D., Msall, M. E., Health, functioning, and participation of adolescents and adults with cerebral palsy: a review of outcomes research, Developmental Disabilities Research Reviews, 18, 84-94, 2013	No intervention
Fucs, P. M. M. B., Svartman, C., Assumpcao, R. M. C., Yamada, H. H., Rancan, D. R., Is arthrodesis the end in spastic hip disease?, Journal of Pediatric Rehabilitation Medicine, 4, 163-169, 2011	Results of operation for dislocated hips
Geertsen, S. S., Kirk, H., Lorentzen, J., Jorsal, M., Johansson, C. B., Nielsen, J. B., Impaired gait function in adults with cerebral palsy is associated with reduced rapid force generation and increased passive stiffness, Clinical NeurophysiologyClin Neurophysiol, 126, 2320-9, 2015	No intervention
Gordon, J., Physiotherapy and occupational therapy for people with cerebral palsy: a problem-based approach to assessment and management, British Journal of Occupational Therapy, 75, 252-252, 2012	Type of Article: Book Review
Hatta,T., Nishimura,S., Inoue,K., Yamanaka,M., Maki,M., Kobayashi,N., Kishigami,H., Sato,M., Evaluating the relationships between the postural adaptation of patients with profound cerebral palsy and the configuration of the Seating Buggy's seating support surface, Journal of Physiological Anthropology, 26, 217-224, 2007	Not effectiveness study
Hergenroder,H., Blank,R., Subjective well-being and satisfaction with life in adults with spastic cerebral palsy: a pilot study of a randomized sample, Developmental Medicine and Child Neurology, 51, 389-396, 2009	Not intervention evaluation
Hinderer, S. R., Gupta, S., Functional outcome measures to assess interventions for spasticity, Archives of Physical Medicine and Rehabilitation, 77, 1083-1089, 1996	No intervention
Hombergen, S. P., Huisstede, B. M., Streur, M. F., Stam, H. J., Slaman, J., Bussmann, J. B., van den Berg-Emons, R. J., Impact of cerebral palsy on health-related physical fitness in adults: systematic review, Archives of Physical Medicine & Rehabilitation, 93, 871-81, 2012	CP Vs non CP comparison
Horsman, M., Suto, M., Dudgeon, B., Harris, S. R., Growing older with cerebral palsy: insiders' perspectives, Pediatric Physical Therapy, 22, 296-303, 2010	Qualitative Study
Hundertmark, L. H., Evaluating the adult with cerebral palsy for specialized adaptive seating, Physical Therapy, 65, 209-12, 1985	Single case report

Jahnsen,R., Villien,L., Egeland,T., Stanghelle,J.K., Holm,I., Locomotion skills in adults with cerebral palsy, Clinical Rehabilitation, 18, 309-316, 2004	Cross-sectional retrospective survey
Jeglinsky, I, Surakka, J, Brogren, Carlberg E, Autti-Ramo, I, Evidence on physiotherapeutic interventions for adults with cerebral palsy is sparse: a systematic review (Provisional abstract), Clinical Rehabilitation, 24, 771-788, 2010	RCTs in review already included
Johnstone, B. R., Richardson, P. W. F., Coombs, C. J., Duncan, J. A., Functional and cosmetic outcome of surgery for cerebral palsy in the upper limb, Hand Clinics, 19, 679-686, 2003	Average age 15.6 years
Jones, L., Van Miert, C., Holmes, G., Pearn, L., Jariwala, M., Winney, A., Muscle strengthening for children and adults with cerebral palsy, Cochrane Database of Systematic Reviews, (4), 2009	Mean age group in all included RCTs <16 yrs
Katalinic, O. M., Harvey, L. A., Herbert, R. D., Effectiveness of Stretch for the Treatment and Prevention of Contractures in People With Neurological Conditions: A Systematic Review, Physical Therapy, 91, 11-24, 2011	Few studies on CP, (most on other neurological conditions) all including children
Katalinic, O. M., Harvey, L. A., Herbert, R. D., Moseley, A. M., Lannin, N. A., Schurr, K., Stretch for the treatment and prevention of contractures, Cochrane Database of Systematic Reviews, 2010	Includes 2 studies of CP, both in children
Kerr, C., McDowell, B., McDonough, S., Electrical stimulation in cerebral palsy: A review of effects on strength and motor function, Developmental Medicine and Child Neurology, 46, 205-213, 2004	Age group less than 16 years
Kirk, H., Geertsen, S. S., Lorentzen, J., Krarup, K. B., Bandholm, T., Nielsen, J. B., Explosive Resistance Training Increases Rate of Force Development in Ankle Dorsiflexors and Gait Function in Adults With Cerebral Palsy, Journal of Strength & Conditioning Research, 30, 2749-60, 2016	Explorative trial (Non random assignment)
Kloyiam, S., Breen, S., Jakeman, P., Conway, J., Hutzler, Y., Soccer-specific endurance and running economy in soccer players with cerebral palsy, Adapted Physical Activity Quarterly, 28, 354-367, 2011	No intervention
Koldoff, E. A., Holtzclaw, B. J., Physical Activity Among Adolescents with Cerebral Palsy: An Integrative Review, Journal of Pediatric Nursing, 30, e105-17, 2015	Not related to interventions in adults with CP
Kramer, J. F., MacPhail, H. E. A., Relationships among measures of walking efficiency, gross motor ability, and isokinetic strength in adolescents with cerebral palsy, Pediatric Physical Therapy, 6, 3-8, 1994	No intervention
Kusumoto, Y., Nitta, O., Matsuo, A., Takaki, K., Matsuda, T., Factors contributing to satisfaction with changes in physical function after orthopedic surgery for musculoskeletal dysfunction in patients with cerebral palsy, PLoS ONE, 11 (5) (no pagination), 2016	Related to satisfaction, rather than physical function change
Laffont, I., Guillon, B., Fermanian, C., Pouillot, S., Even-Schneider, A., Boyer, F., Ruquet, M., Aegerter, P., Dizien, O., Lofaso, F., Evaluation of a Stair-Climbing Power Wheelchair in 25 People With Tetraplegia, Archives of Physical Medicine and Rehabilitation, 89, 1958-1964, 2008	Only 3 adults with cerebral palsy included
Lampe, R., Mitternacht, J., Schrodl, S., Gerdesmeyer, L., Natrath, M., Gradinger, R., Influence of orthopaedic-technical aid on the	Outcomes not related to physical function, mixed population

kinematics and kinetics of the knee joint of patients with neuro-orthopaedic diseases, Brain & Development, 26, 219-26, 2004	
Lennon, N., Thorpe, D., Balemans, A. C., Fragala-Pinkham, M., O'Neil, M., Bjornson, K., Boyd, R., Dallmeijer, A. J., The clinimetric properties of aerobic and anaerobic fitness measures in adults with cerebral palsy: A systematic review of the literature, Research in Developmental Disabilities, 45-46, 316-28, 2015	Not related to intervention efficiency but clinimetric properties of aerobic and anaeroobic capacity measures
Liang, S., Zhao, Y., Xu, Y. P., Liu, H. T., Zhang, S. M., Wang, L. P., Gao, C. X., The application of conductive education approach in walk training of cerebral palsy, Chinese Journal of Clinical Rehabilitation, 6, 3624, 2002	Full text Article not in English
Liptak, G. S., Health and well being of adults with cerebral palsy, Current Opinion in Neurology, 21, 136-42, 2008	Review with mixed population and outcomes. Study related to intervention in adults included
Maanum, G., Jahnsen, R., Fr, OSlie K. F., Larsen, K. L., Keller, A., Walking ability and predictors of performance on the 6-minute walk test in adults with spastic cerebral palsy, Developmental Medicine and Child Neurology, 52, e126-e132, 2010	No intervention
Maanum, G., Jahnsen, R., Stanghelle, J. K., Sandvik, L., Larsen, K. L., Keller, A., Validity of the Gait Deviation Index in adults with spastic cerebral palsy: An explorative study from a randomized controlled trial, Developmental medicine and child neurology, 53, 87-8, 2011	Not physical activity intervention
Maanum,G., Jahnsen,R., Stanghelle,J.K., Sandvik,L., Larsen,K.L., Keller,A., Face and construct validity of the Gait Deviation Index in adults with spastic cerebral palsy, Journal of Rehabilitation Medicine, 44, 272-275, 2012	Validity of scale, not effectiveness of intervention
MacKinnon, J. R., Noh, S., Lariviere, J., MacPhail, A., Allan, D. E., Laliberte, D., A study of therapeutic effects of horseback riding for children with cerebral palsy, Physical & Occupational Therapy in Pediatrics, 15, 17-34, 1995	Age below 16 years
MacPhail, H. E., Kramer, J. F., Effect of isokinetic strength-training on functional ability and walking efficiency in adolescents with cerebral palsy, Developmental Medicine & Child Neurology, 37, 763-75, 1995	RCTs available for this question
Montesano,L., Diaz,M., Bhaskar,S., Minguez,J., Towards an intelligent wheelchair system for users with cerebral palsy, IEEE Transactions on Neural Systems and Rehabilitation Engineering, 18, 193-202, 2010	Age below 16 years
Nomura, T., Orthopedic surgery in cases of cerebral palsy, Neurological Surgery, 29, 1153-1165, 2001	Article not in English language
Pitchay, S., Remedios, C., Effectiveness of suit therapy on children with cerebral palsy: A literature review, Developmental Medicine and Child Neurology, 54, 86, 2012	Average age: 6 years
Pitetti, K. H., Fernandez, J. E., Lanciault, M. C., Feasibility of an exercise program for adults with cerebral palsy: A pilot study, Adapted Physical Activity Quarterly, 8, 333-341, 1991	Outcomes of interest not reported
Root, L., Laplaza, F. J., Brourman, S. N., Angel, D. H., The severely unstable hip in cerebral palsy. Treatment with open reduction, pelvic osteotomy, and femoral osteotomy with shortening, Journal of Bone & Joint Surgery - American Volume, 77, 703-12, 1995	No physical function outcomes

Root,L., Miller,S.R., Kirz,P., Posterior tibial-tendon transfer in patients with cerebral palsy, Journal of Bone and Joint Surgery - American Volume, 69, 1133-1139, 1987	Mean age less than 16 yrs
Ross, S. M., Macdonald, M., Bigouette, J. P., Effects of strength training on mobility in adults with cerebral palsy: A systematic review, Disability and Health Journal, 9, 375-384, 2016	Individual studies included
Ryan, J. M., Cassidy, E. E., Noorduyn, S. G., O'Connell, N. E., Exercise interventions for cerebral palsy, Cochrane Database of Systematic ReviewsCochrane Database Syst Rev, 6, CD011660, 2017	The one adult study included in this systematic review is already included in our review.
Ryan,J.M., Crowley,V.E., Hensey,O., Broderick,J.M., McGahey,A., Gormley,J., Habitual physical activity and cardiometabolic risk factors in adults with cerebral palsy, Research in Developmental Disabilities, 35, 1995-2002, 2014	No intervention
Sahlin, K. B., Lexell, J., Impact of Organized Sports on Activity, Participation, and Quality of Life in People With Neurologic Disabilities, PM and R, 7, 1081-1088, 2015	Review focuses on spinal cord injuries cases
Sakzewski,L., Ziviani,J., Boyd,R.N., Efficacy of upper limb therapies for unilateral cerebral palsy: a meta-analysis, Pediatrics, 133, e175-e204, 2014	Age less than 16 years
Samilson, R. L., Orthopedic-Surgery of the Hips and Spine in Retarded Cerebral-Palsy Patients, Orthopedic Clinics of North America, 12, 83-90, 1981	Opinion piece
Schiariti, V., Fayed, N., Cieza, A., Klassen, A., O'Donnell, M., Content Comparison of Health Related Quality of Life Measures for Cerebral Palsy Based on the International Classification of Functioning (Icf-Cy), Acta PaediatricaActa Paediatr, 98, 228-228, 2009	No intervention
Schiariti,V., Fayed,N., Cieza,A., Klassen,A., O'donnell,M., Content comparison of health-related quality of life measures for cerebral palsy based on the International Classification of Functioning, Disability and Rehabilitation, 33, 1330-1339, 2011	No intervention
Schopp, L. H., Clark, M. J., Hagglund, K. J., Mokelke, E. K., Stout, B. J., Mazurek, M. O., Evaluation of a consumer-personal assistant training project, Disability and Rehabilitation, 29, 403-410, 2007	Mixed population: Only 6% participants have cerebral palsy
Schweizer, K., Brunner, R., Romkes, J., Upper body movements in children with hemiplegic cerebral palsy walking with and without an ankle-foot orthosis, Clinical Biomechanics, 29, 387-394, 2014	Related to kinematics
Scianni, A., Butler, J. M., Ada, L., Teixeira-Salmela, L. F., Muscle strengthening is not effective in children and adolescents with cerebral palsy: a systematic review, Australian Journal of Physiotherapy, 55, 81-7, 2009	Age less than 16 years
Senft, K. E., Pueschel, S. M., Robison, N. A., Kiessling, L. S., Level of function of young adults with cerebral palsy, Physical and Occupational Therapy in Pediatrics, 10, 19-25, 1990	No intervention
Slaman, J., Bussmann, J., Van Der Slot, W. M., Stam, H. J., Roebroeck, M. E., Van Den Berg-Emons, R. J., Physical strain of walking relates to activity level in adults with cerebral palsy, Archives of Physical Medicine and Rehabilitation, 94, 896-901, 2013	No intervention

Slaman, J., Roebroeck, M., Dallmijer, A., Twisk, J., Stam, H., Van Den Berg-Emons, R., Can a lifestyle intervention programme improve physical behaviour among adolescents and young adults with spastic cerebral palsy? A randomized controlled trial, Developmental medicine and child neurology, 57, 159-166, 2015	This evidence has already been used in Spasticity Under 19 Guideline
Slaman, J., Roebroeck, M., van der Slot, W., Twisk, J., Wensink, A., Stam, H., van den Berg-Emons, R., Learn Move Research Group, Can a lifestyle intervention improve physical fitness in adolescents and young adults with spastic cerebral palsy? A randomized controlled trial, Archives of Physical Medicine & Rehabilitation, 95, 1646-55, 2014	Outcomes not related to physical function
Slaman, J., Roebroek, M., Stam, H., Van Den Berg-Emons, H., Effectiveness of a lifestyle program on daily physical activity and fitness in adolescents and young adults with cerebral palsy: A randomized controlled trial, Developmental medicine and child neurology, 55, 30-1, 2013	conference abstract
Takken, T., Helders, P., Description of Exercise Participation of Adolescents With Cerebral Palsy Across a 4-Year Period, Pediatric Physical Therapy, 22, 188-188, 2010	Not primary study- Clinical Bottom Line
Taneja, S., Narang, S., Midha, T., Drop Outs from a Cerebral Palsy Physiotherapy Program : A Clinical Appraisal, European Journal of Pediatrics, 175, 1689-1690, 2016	Age group less than 16 years
Taylor, N. F., Dodd, K. J., Larkin, H., Adults with cerebral palsy benefit from participating in a strength training programme at a community gymnasium, Disability & Rehabilitation, 26, 1128-34, 2004	Single group study
Thorpe, D., The role of fitness in health and disease: status of adults with cerebral palsy, Developmental Medicine & Child Neurology, 51 Suppl 4, 52-8, 2009	Abstract of Conference
Thorpe, D. E., McMurray, R., Henderson, R., Turk, M. A., Adults with cerebral palsy training to increase overall wellness: Project act now, Developmental Medicine and Child Neurology, 53, 53-54, 2011	Conference abstract
Thyberg, M., Gerdle, B., Samuelsson, K., Larsson, H., Wheelchair seating intervention. Results from a client-centred approach, Disability and Rehabilitation, 23, 677-682, 2001	Results not analyzed separately for 4 subjects with CP
Unger,M., Faure,M., Frieg,A., Strength training in adolescent learners with cerebral palsy: a randomized controlled trial, Clinical Rehabilitation, 20, 469-477, 2006	This evidence has already been used in Spasticity Under 19 Guideline
Usuba, K., Oddson, B., Gauthier, A., Young, N. L., Leisure-Time Physical Activity in adults with Cerebral Palsy, Disability and Health Journal, 8, 611-618, 2015	No intervention
van der Dussen, L., Niewstraten, W., Roebroeck, M., Stam, H. J., Functional level of young adults with cerebral palsy, Clinical Rehabilitation, 15, 84-91, 2001	No intervention
van der Slot Wilma, M. A., Roebroeck, M. E., Landkroon, A. P., Terburg, M., van den Berg-Emons, R. J. G., Stam, H. J., Everyday physical activity and community participation of adults with hemiplegic Cerebral Palsy, Disability and Rehabilitation, 29, 179-189, 2007	No intervention
van Hedel, H. J. A., Meyer-Heim, A., Rusch-Bohtz, C., Robot-assisted gait training might be beneficial for more severely affected children with cerebral palsy, Developmental neurorehabilitation, 19, 410-415, 2016	Mean age of 11.2 years

Van Heest, A. E., Ramachandran, V., Stout, J., Wervey, R., Garcia, L., Quantitative and qualitative functional evaluation of upper extremity tendon transfers in spastic hemiplegia caused by cerebral palsy, Journal of Pediatric Orthopaedics, 28, 679-683, 2008	Mean age of 10.8 years
Verschuren, O., Ketelaar, M., Gorter, J. W., Helders, P. J. M., Takken, T., Relation between physical fitness and gross motor capacity in children and adolescents with cerebral palsy, Developmental Medicine and Child Neurology, 51, 866-871, 2009	Mean age less than 16 years
Verschuren, O., Peterson, M. D., Balemans, A. C. J., Hurvitz, E. A., Exercise and physical activity recommendations for people with cerebral palsy, Developmental Medicine and Child Neurology., 2016	Guidance recommendation based on mixed population, mostly children
Vogtle, L. K., Malone, L. A., Azuero, A., Outcomes of an exercise program for pain and fatigue management in adults with cerebral palsy, Disability & Rehabilitation, 36, 818-25, 2014	Repeated measures design
Warms, C. A., Belza, B. L., Whitney, J. D., Correlates of physical activity in adults with mobility limitations, Family & Community Health, 30, S5-S16, 2007	No intervention
Wiart, L., Darrah, J., Cook, A., Hollis, V., May, L., Evaluation of powered mobility use in home and community environments, Physical and Occupational Therapy in Pediatrics, 23, 59-75, 2003	Mean age of 15.2 years
Wiart, L., Rosychuk, R. J., Wright, F. V., Evaluation of the effectiveness of robotic gait training and gait-focused physical therapy programs for children and youth with cerebral palsy: A mixed methods RCT, BMC Neurology, 16 (1) (no pagination), 2016	Research Protocol

CP: cerebral palsy; RCT: randomised controlled trial

Economic studies

No economic evidence was identified for this review.

Appendix L – Research recommendations

Research recommendations for review question D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

What is the optimum regime for orthoses applied to the upper limb in adults with cerebral palsy to improve or maintain posture or function?

Table 21: Research recommendation rationale

Research question	What is the optimum regime for orthoses applied to the upper limb in adults with cerebral palsy to improve or maintain posture or function?

Importance to 'patients' or the population	• Improved independence, for example:
	  ○ Wheelchair independence
	  ○ Increased gait efficiency nb. Endurance/ speed/reduced falls
	  ○ Access to technology, which may enable communication
	  ○ Self Care
	  ○ Desk top – school/employment
	  ○ Sporting
	  ○ Reduce pain/discomfort – enable rest
	  ○ Handwriting, feeding computer use
	• Reduce pain
	• Reduce need for surgical intervention
	• Allow ease of administration of care

Relevance to NICE guidance	Ability to define the value of this treatment approach
Relevance to the NHS	Reduce surgical or pharmacological costs Reduce health related issues secondary to fixed contractures Establish consistency in availability of most effective/cost effective orthosis
National priorities	Reduce variation in treatment Improve participation for adults with Cerebral Palsy NCEPOD Chronic Neurodisability Study
Current evidence base	Current evidence was not clear and was graded as very low quality with high rates of imprecision
Equality	Applies to all adults with cerebral palsy and upper limb problems related to spasticity or dystonia

NCEPOD: National Confidential Enquiry into Patient Outcome and Death; NHS: National Health Service; NICE: National Institute for Health and Care Excellence.

Table 22: Research recommendation modified PICO table

Criterion	Explanation
Population	Adults (16 or over) with cerebral palsy who have dystonia or spasticity causing functional impairment or postural changes in the upper limbs
Intervention	Application of orthoses
Comparator	• Treatment as usual • No treatment

Outcome	• Patient satisfaction
	• Ease of care administration
	• Treatment-related morbidity
	• HRQoL
	• In-hand hygiene and in-hand skin integrity
	• Functional ability
	  ○ GAS/ GAS lite
	Self-reported measures such as the:
	  ○ VAS or NRS for pain
	  ○ DASH or TOMS for function/participation.
	  ○ ARM-A; ARM-B
	Measures can also be used to objectively determine performance for dexterity 9-hole peg test; grip and pinch strength

Study design	Large Multicentre cohort study
Timeframe	5 years
Additional information	Need to stratify by: Type of motor abnormality: • Dystonia • Spasticity Consider additional / previous interventions • Surgery • Systemic treatments (muscle relaxants, dystonia medication) • Therapy input

DASH: disabilities of the Arm, Shoulder and Hand; FES: Functional electrical stimulation; GAS: goal attainment scaling; HRQoL, health-related quality of life; ITB: intrathecal baclofen; NRS: numerical rating scale; TOM: therapy outcome measure; TUG: timed up and go; VAS: visual analogue scale