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Research

Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: a systematic review

Katharine Scrivener ^a, Simone Dorsch ^{b,c}, Annie McCluskey ^{c,d}, Karl Schurr ^c, Petra L Graham ^e, Zheng Cao ^f, Roberta Shepherd ^d, Sarah Tyson ^g

^a Department of Health Professions, Macquarie University, Sydney, Australia; ^b Faculty of Health Sciences, Australian Catholic University, Australia; ^c The StrokeEd Collaboration, Sydney, Australia; ^d Faculty of Medicine and Health, The University of Sydney, Sydney, Australia; ^e Centre for Economic Impacts of Genomic Medicine (GenIMPACT), Macquarie University, Sydney, Australia; ^f Hammondcare, Sydney, Australia; ^g School of Health Sciences, University of Manchester, Manchester, UK

KEY WORDS

Bobath
Stroke
Physical therapy
Walking
Lower limb

ABSTRACT

Question: In adults with stroke, does Bobath therapy improve lower limb activity performance, strength or co-ordination when compared with no intervention or another intervention? **Design:** Systematic review of randomised trials with meta-analyses. **Participants:** Adults after stroke. **Intervention:** Bobath therapy compared with another intervention or no intervention. **Outcome measures:** Lower limb activity performance (eg, sit to stand, walking, balance), lower limb strength and lower limb co-ordination. Trial quality was assessed using the PEDro scale. **Results:** Twenty-two trials were included in the review and 17 in the meta-analyses. The methodological quality of the trials varied, with PEDro scale scores ranging from 2 to 8 out of 10. No trials compared Bobath therapy to no intervention. Meta-analyses estimated the effect of Bobath therapy on lower limb activities compared with other interventions, including: task-specific training (nine trials), combined interventions (four trials), proprioceptive neuromuscular facilitation (one trial) and strength training (two trials). The pooled data indicated that task-specific training has a moderately greater benefit on lower limb activities than Bobath therapy (SMD 0.48), although the true magnitude of the benefit may be substantially larger or smaller than this estimate (95% CI 0.01 to 0.95). Bobath therapy did not clearly improve lower limb activities more than a combined intervention (SMD -0.06, 95% CI -0.73 to 0.61) or strength training (SMD 0.35, 95% CI -0.37 to 1.08). In one study, Bobath therapy was more effective than proprioceptive neuromuscular facilitation for improving standing balance (SMD -1.40, 95% CI -1.92 to -0.88), but these interventions did not differ on any other outcomes. Bobath therapy did not improve strength or co-ordination more than other interventions. **Conclusions:** Bobath therapy was inferior to task-specific training and not superior to other interventions, with the exception of proprioceptive neuromuscular facilitation. Prioritising Bobath therapy over other interventions is not supported by current evidence. **Registration:** PROSPERO CRD42019112451. [Scrivener K, Dorsch S, McCluskey A, Schurr K, Graham PL, Cao Z, Shepherd R, Tyson S (2020) Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: a systematic review. *Journal of Physiotherapy* ■-■-■]

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Introduction

The Bobaths developed a method of treating children with cerebral palsy and adults with stroke in the 1950s.¹ Their method differed from other physiotherapy methods at the time, as it was based on the assumptions that: performance could be facilitated by the therapist; spasticity could be inhibited, thus permitting more normal movement; and these interventions could optimise recovery from the brain damage. As time passed, Bobath therapy, along with other new therapeutic methods such as proprioceptive neuromuscular facilitation (PNF), became more commonly used by neurological physiotherapists internationally.

Research into neuromotor control and movement science refutes the assumptions that underpin these methods. For example, research findings indicate that spasticity is not correlated with activity and participation measures after stroke.^{2,3} In contrast, loss of strength has been found to correlate highly with activity limitations, and strength training has been shown to improve strength and motor activity after stroke.³⁻⁵ Additionally, research findings indicate that motor skill acquisition is dependent on the individual performing active and repetitive practice of that skill, learning again to control movement in relevant environments.⁶ This contrasts with Bobath therapy, which assumes that movement control is dependent on therapists facilitating 'normal' movement patterns.⁷⁻¹⁰

Despite its extensive clinical use, the efficacy of Bobath therapy has not been established. Efficacy of Bobath therapy would be most directly established by trials of Bobath therapy versus no intervention. A search of the PEDro database identifies no systematic reviews that compare Bobath therapy versus no intervention. To date, three systematic reviews have compared Bobath therapy with other interventions.^{11–13} These reviews did not include a pooled analysis of outcomes and were unable to provide any definitive conclusions. An additional systematic review compared Bobath therapy with other interventions, and pooled analyses of outcomes indicated that specific interventions, such as task-specific training, may be more effective than Bobath therapy.¹⁴ However, this review did not include a comprehensive search and analysis of trials comparing Bobath therapy with other interventions, as this was not the objective.

The primary aim of this systematic review was to evaluate the effect of Bobath therapy on lower limb activities after stroke. The secondary aim was to evaluate the effect of Bobath therapy on lower limb impairments, strength and co-ordination after stroke.

Therefore, the research question for this systematic review was:

In adults with stroke, does Bobath therapy improve lower limb activity performance, strength or co-ordination when compared with no intervention or other intervention?

Methods

The PRISMA statement was used to guide the reporting of this review.¹⁵

Identification and selection of studies

An electronic search for relevant trials was conducted in January 2019. The following databases were searched: Ovid MEDLINE, EMBASE, CINAHL and PEDro. The search included terms related to stroke, randomised controlled trial and Bobath, including 'neuro-developmental treatment', as this is the common term for Bobath therapy in the United States of America.¹⁶ Refer to Appendix 1 on the eAddenda for the full details of the search strategy.

Titles and abstracts were screened independently by two authors (KS and ST) to identify relevant trials. Full text copies of relevant papers were retrieved and reviewed independently by two authors (KS and ST) using predetermined criteria to determine eligibility (Box 1). If the two reviewers disagreed about the eligibility of a trial, a discussion was held with a third author (AM) until a consensus was reached. Where abstracts or full-text reports were only available in another language, a person fluent in that language reviewed these trials and discussed results with fellow authors. Where they were only available in Chinese, one author (ZC) reviewed these trials.

Assessment of characteristics of the studies

Risk of bias

The PEDro database was searched to identify the PEDro scale score and each trial was then reviewed by two co-authors to confirm the

PEDro scale score. Where a trial was not listed on the PEDro database, two authors independently rated the trial using the PEDro scale.¹⁷

Participants

Participants in the included trials were adults at various stages after stroke.

Intervention

Trials that included physiotherapy based on Bobath therapy were included. To determine if Bobath therapy was used, trials had to meet one of the following criteria: the authors explicitly stated that the intervention was based on Bobath or neuro-developmental training; the authors referenced a Bobath textbook or publication when describing the intervention; or the intervention description suggested that it was based on Bobath therapy (ie, aimed to normalise movement, normalise tone, facilitate normal movement or inhibit reflex activity). If it was unclear whether the intervention was Bobath therapy, the authors were contacted. If the intervention was mixed, it needed to be clearly stated that at least half of the intervention was Bobath therapy.

Comparison

The comparisons of interest were another intervention or no intervention. Two authors reviewed all comparison interventions and grouped them into broad categories.

Outcome measures

To be included within the review, trials needed to include an outcome measure of lower limb activity, the primary outcome measure for this review. Data were extracted for the following lower limb activities: sitting balance, standing up and sitting down (referred to as sit-to-stand), standing balance, walking, running and stair climbing. The secondary outcomes were measures of lower limb strength or co-ordination. These were extracted from included trials where they were reported. For the overall summary of lower limb activity, outcome measures were included that best reflected the purpose of each trial's intervention. Where possible a trial's primary measure was selected.

Data extraction and analysis

Two research assistants independently examined the full-text version of the included trials to extract data. The number of participants, their age, time since stroke and inclusion criteria were recorded to describe the sample. Post-intervention mean scores and standard deviations were retrieved where possible (in preference to change scores) because these data were most often provided. Authors were contacted for missing data. Differences between reviewers were resolved by a third reviewer (KS). All extracted data were checked for accuracy by the review statistician (PG).

As a variety of outcome measures were reported, standardised mean differences (SMD) were used to provide pooled estimates of intervention effect via DerSimonian and Laird random-effects meta-analyses.¹⁸ A mean difference calculation was planned; however, due to the variety of outcome measures used, this was unable to be conducted. Therefore, all results were reported as SMD (treatment – Bobath) with 95% confidence interval (CI). For most outcome measures, a higher score indicated a better outcome. For the few outcome measures in which lower scores indicated a better outcome, negative signs were applied to the mean scores. Where post-intervention results were reported as medians and interquartile ranges, the methods of Hozo et al were used to convert the results into means and standard deviations.¹⁹ Heterogeneity between trials was assessed using Cochrane's Q , with p -values < 0.05 indicating significant heterogeneity, and the I^2 statistic, which measures the proportion of variability in estimated effects due to heterogeneity. I^2 values of 25, 50 and 75% are commonly referred to as reflecting low, moderate and high heterogeneity, respectively.²⁰ Sensitivity analyses were undertaken, whereby influential trials were removed to determine how overall summaries and heterogeneity was impacted. R statistical software with the meta package was used for all analyses.^{21,22}

Box 1. Inclusion criteria.

Design

- Randomised trial

Participants

- Adults after stroke

Intervention

- At least one group received therapy based on the Bobath concept
- At least one group received a comparison intervention or no intervention

Outcome measures

- Functional outcome relating to a lower limb activity

Results

Flow of studies through the review

The electronic search strategy identified 2,506 papers excluding duplicates. After screening titles and abstracts, 128 full-text publications were retrieved and screened for eligibility. Two authors were contacted to confirm whether their intervention was Bobath therapy.^{23,24} Based on their response, one trial was included and one was excluded. The full-text publications of 10 trials written in Chinese and full-text publications in Japanese, French and Danish were reviewed. However, none of these trials met the inclusion criteria. The reference list of a Cochrane review and other systematic reviews of therapy approaches were screened but no additional relevant trials were identified.^{11–14} Twenty-two trials were included in the review and 17 in the meta-analyses (Figure 1).

Characteristics of the included studies

Of the included 22 trials, four had no data that could be extracted for the meta-analysis, and the authors were unable to provide additional data.^{25–28} These trials were included in the review, with results presented separately. Based on available data in these trials, we attempted to calculate mean estimates and confidence intervals, but this was not possible and therefore the results were presented narratively.

Three publications from the same trial by Langhammer et al were identified, which reported data at different time points.^{29–31} The first publication reported outcomes before and after intervention,²⁹ the second included a later follow-up and the third reported previously unreported data from the first assessment period.^{30,31} In the current meta-analysis, we primarily included data from the first publication. Data from the third publication were included in secondary meta-analyses, which focused on a specific activity (where data about that activity were unavailable in the first study). Data from the second

publication were excluded from the meta-analysis and the results are presented separately.

Of the 22 included trials, all except one were written in English; that trial was written in Lithuanian with an English abstract.²⁷ The authors initially used Google Translate to translate that publication; the extracted information was then confirmed by a person fluent in Lithuanian. All of the 22 trials compared Bobath therapy with another intervention. The trials included a total of 1,192 unique participants. Most trials (n = 12) were set in a rehabilitation hospital setting; however, trials conducted later after stroke were also included. See Table 1 for details regarding each of the included trials.

Risk of bias

Risk of bias in the included trials was variable, with PEDro scores ranging from 2 to 8 out of 10 (Table 2). No trials were able to blind stroke participants or therapists to group allocation. Seven trials did not use blinded assessors and five trials included groups that were dissimilar at baseline.

Participants

The average age of participants ranged from 34 to 75 years. The average time after stroke ranged from 6 days to 6 months (Table 1).

Intervention

Bobath therapy was explicitly described by authors in 19 of the trials and referenced using a Bobath textbook in two trials.^{25,43} One author confirmed that the conventional physiotherapy intervention described in their trial was Bobath therapy.²⁴ The average dose of Bobath therapy provided was 17 hours (range 6 to 38) among the 12 trials that reported session time in enough detail to calculate dose.

Comparison interventions were allocated to one of five broad categories based on the components of the intervention and these included task-specific training, strength training, PNF, robotics or combined interventions. Full details of the comparison interventions can be found in Appendix 2a and 2b on the eAddenda.

Effect of Bobath therapy compared with no intervention

No trials compared Bobath therapy with no intervention or sham intervention for any of the primary outcomes.

Effect of Bobath therapy on lower limb activity compared with other interventions

Primary outcome measures

Various lower limb activity measures were reported. For the analysis of lower limb activity, a measure of walking was used in five trials, an overall measure of functional mobility was used in five trials, a measure of standing balance was used in four trials and a measure of sitting balance was used in two trials. Walking was most often measured using walking speed. Standing balance was most often measured using the Berg Balance Scale.

The effect of Bobath therapy compared with task-specific training on lower limb activity was examined by pooling outcomes from nine trials (mean PEDro score = 6.6) involving a total of 487 participants (Figure 2, bottom). The pooled SMD was moderate (SMD 0.48) in favour of task-specific training, although the true size of the effect may be substantially smaller or larger than this estimate (95% CI 0.01 to 0.95, $I^2 = 84%$). The effect of Bobath therapy compared with strength training was examined by pooling outcomes from two trials (mean PEDro score = 5.5) involving 30 participants (Figure 2, lower middle). The SMD was 0.35 in favour of strength training; however, this estimate was very imprecise (95% CI -0.37 to 1.08, $I^2 = 0%$). The effect of Bobath therapy compared with PNF was examined in one trial (PEDro score = 4) involving 72 participants (Figure 2, upper middle). The SMD was -1.40 (95% CI -1.92 to -0.88) in favour of Bobath therapy. The effect of Bobath therapy compared with a

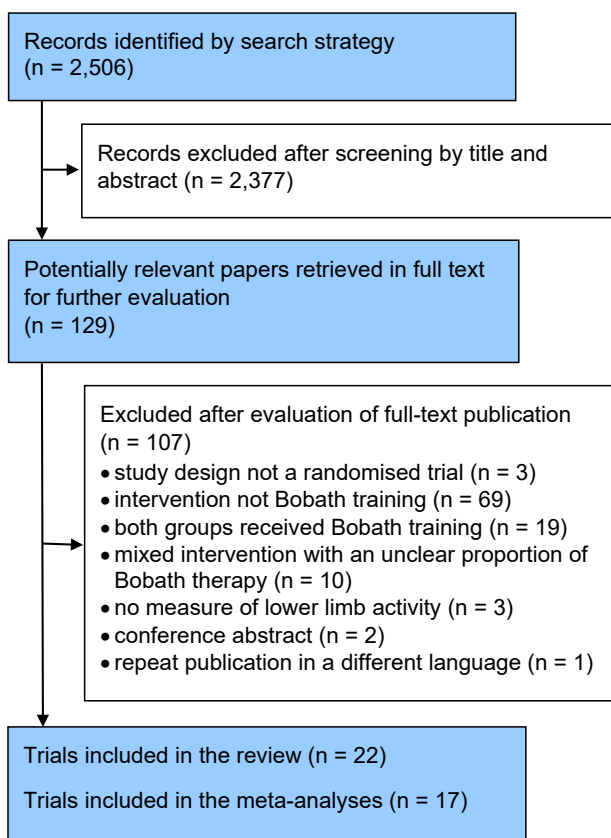


Figure 1. Flow of trials through the review.

Table 1
Characteristics of included trials.

Trial	Participants	Intervention	Activity level outcome measures	
			Measures	Times
Bale 2008 ³²	n = 18 Subacute phase (2 wk to 6 mth) Two rehabilitation units, hospital ward and rehabilitation centre Inclusion criteria: leg weakness, understands instructions, able to sit unsupported, medically stable Time since stroke (d): Bobath 32 (19), Other 49 (22) Age (yr): Bobath 65 (9), Other 61 (13)	Bobath (n = 10): training influenced by Bobath concept. Time: 50 min/d, 5 d/wk for 4 weeks Comparison (n = 8): Functional strength training, mainly performed in weight bearing (10RM to 15RM). Time: 50 min/d, 3 d/wk, (arm activities on other 2 days) for 4 wk	<ul style="list-style-type: none"> Maximal weight bearing on affected leg in standing Walk speed (over 8 m) Motor Assessment Scale (STS and walking items) 	4 wk
Brock 2011 ³³	n = 26 4 to 20 weeks after stroke Two rehabilitation centres Inclusion criteria: able to walk 15 m with supervision indoors Time since stroke (d): Bobath 60 (24), Other 64 (26) Age (yr): Bobath 61 (13), Other 57 (16)	Bobath (n = 12): Bobath with some structured task practice Comparison (n = 14): structured task practice, no hands-on therapist assistance Both: 60 min/d, 3 d/wk for 2 wk	<ul style="list-style-type: none"> Adapted 6MWT Walk speed Berg Balance Scale 	2 wk
Dias 2007 ²⁵	n = 40 Chronic post stroke (> 12 mth) Inclusion criteria: LL motor deficit, first stroke Time since stroke (d): Bobath 49 (30), Other 47 (64) Age (yr): Bobath 68 (11), Other 70 (7)	Bobath (n = 20): gait training with therapist facilitation Comparison (n = 20): robotic gait trainer Both: 40 min/d, 5 d/wk for 5 wk	<ul style="list-style-type: none"> Step test Walk speed Berg Balance Scale Rivermead Mobility Index 	5 wk 3 mth
Dickstein 1986 ²⁶	n = 131 Referred from a geriatric rehabilitation hospital Time since stroke (d): 16 days since hospital admission Age (yr): 71 (8)	Bobath (n = 38): Bobath method Comparison 1 (n = 57): combined intervention including active and passive range of motion, strength training and functional activities Comparison 2 (n = 36): PNF All: 30 to 45 min, 5 d/wk, for 6 wk	<ul style="list-style-type: none"> Ambulatory status Barthel Index 	6 wk
Gelber 1995 ³⁴	n = 27 Acute neurorehabilitation unit Inclusion criteria: pure motor ischaemic stroke Time since stroke (d): Bobath 11 (1), Other 14 (3) Age (yr): Bobath 74 (2), Other 70 (3)	Bobath (n = 15): NDT-based treatment Comparison (n = 12): combined intervention including ROM, strength training and functional task practice (compensations allowed) Both: no prescriptive details described in the text	<ul style="list-style-type: none"> FIM Gait speed Stride length 	admission discharge 6 mth 12 mth
Kılınc 2016 ³⁵	n = 22 Subacute stage (< 6 months) Inclusion criteria: less than full points on TIS, must be able to sit/walk independently (with aid) Time since stroke (mth): Bobath 59 (56), Other 67 (43) Age (yr): Bobath 56 (8), Other 54 (14)	Bobath (n = 12): Bobath therapy (with a focus on the trunk) Comparison (n = 10): combined intervention comprising strength, stretch, mat, function, ROM Both: 1 hr/d, 3 d/wk for 12 wk	<ul style="list-style-type: none"> Berg Balance Scale Stroke Rehabilitation Assessment of Movement Trunk Impairment Scale Functional Reach Test 10mWT Timed Up and Go 	12 wk
Krukowska 2016 ³⁶	n = 72 Acute stage (< 6 months) Rehabilitation clinic Inclusion criteria: ischaemic stroke, stand independently Time since stroke (mth): < 6 Age (yr): Bobath (right) 52 (56), Bobath (left) 54 (7), PNF (right) 52 (8), PNF (left) 53 (7)	Bobath: NDT/Bobath separated into two groups for left (n = 21) and right (n = 17) hemiplegics Comparison: PNF separated into two groups for left (n = 17) and right (n = 17) hemiplegics All: 6 d/wk for 6 wk (total 35 therapy sessions)	<ul style="list-style-type: none"> COP using Alfa balance platform Field support using Alfa balance platform 	6 wk
Krutulytė 2003 ²⁷	n = 240 Rehabilitation hospital Time since stroke: unknown Age (yr): Bobath 64 (1), Other 63 (2)	Bobath (n = 147): four groups based on gender and lesion: female left (n = 7), female right (n = 6), male left (n = 10) and male right (n = 10) Comparison (n = 93): motor relearning program; four groups for gender and lesion location: female left (n = 8), female right (n = 4), male left (n = 9) and male right (n = 7)	<ul style="list-style-type: none"> European Federation for Research in Rehabilitation Scale Barthel Index 	unknown

Langhammer 2000 ²⁹	n = 61 Acute stage Hospital inpatient Inclusion criteria: first stroke, clinically verified with CT Time since stroke (d): ≤ 3 Age (yr): 78 (9)	Bobath (n = 28): Bobath therapy Comparison (n = 33): motor relearning program Both: 40 min/d, 5 d/wk	<ul style="list-style-type: none"> • Motor Assessment Scale • Barthel Index 	2 wk 3 mth
Langhammer 2003 ³⁰	Same population as above. Follow-up study	As above	As above	1 yr 4 yr
Langhammer 2011 ³¹	Same population as above. Follow-up study	As above	As above	3 mth
Mudie 2002 ³⁷	n = 40 Asymmetrical acute stroke (2 to 6 wk) Inpatient rehabilitation unit Inclusion criteria: able to bear weight predominantly on one side, capacity for cognitive relearning Time since stroke (wk): 2 to 6 Age (yr): 72 (9)	Bobath (n = 10): Bobath therapy Comparison 1 (n = 10): training of seated reach with biofeedback Comparison 2 (n = 10): task-specific reach training Control (n = 10): standard physiotherapy and OT program All: 30 min additional to standard therapy	<ul style="list-style-type: none"> • Symmetry of weight distribution in sitting 	3 wk 5 wk 15 wk
Mulder 1986 ³⁸	n = 12 Time since stroke: not reported Age (yr): 34 to 68	Bobath (n = 6): NDT-based treatment Comparison (n = 6): EMG feedback Both: 40 min, 3 d/wk for 5 wk	<ul style="list-style-type: none"> • Gait velocity 	Every session for 5 wk
Richards 1993 ²⁴	n = 27 Acute stroke Hospital Inclusion criteria: middle cerebral artery infarct of thromboembolic origin confirmed by CT Time since stroke: unknown Age: unknown	Bobath (n = 10): focus on gait retraining. Time: approx. 100 min, 2 sessions/d Comparison 1 (n = 8): traditional approach based on older neuro-physical techniques. Time: approx. 107 min, 2 sessions/d Comparison 2 (n = 9): previously prescribed therapy. Time approx. 43 min daily, 1 session/d	<ul style="list-style-type: none"> • Walking speed over 4 m 	6 wk 3 mth 6 mth
Simsek 2016 ³⁹	n = 42 Subacute stage (~8 weeks) Inpatient rehabilitation facility Time since stroke (d): Bobath 60 (31), Other 51 (15) Age (yr): Bobath 62 (12), Other 54 (20)	Bobath (n = 22): Bobath/NDT Comparison (n = 20): balance training using the Nintendo Wii Both: 45 to 60 min, 3 d/wk for 10 wk	<ul style="list-style-type: none"> • FIM 	10 wk
Tang 2005 ⁴⁰	n = 47 Referral from university-based hospital Inclusion criteria: first stroke confirmed by CT or MRI Time since stroke (d): NDT 55 (67), Other 74 (130) Age (yr): NDT 55 (13), Other 57 (11)	Bobath (n = 22): NDT-based treatment Comparison (n = 25): task training with a cognitive/learning focus (problem-oriented therapy) Both: 50 min, 5 to 6 d/wk	<ul style="list-style-type: none"> • Stroke Rehabilitation Assessment of Movement 	8 wk
Thaut 2007 ⁴¹	n = 78 Inclusion criteria: must be able to complete 5 stride cycles with hand held assistance Time since stroke (d): Bobath 22 (12), Other 21 (11) Age (yr): Bobath 70 (11), Other 69 (11)	Bobath (n = 35): NDT/Bobath Comparison (n = 43): walking training with rhythmic auditory cueing Both: 30 min, 5 d/wk for 3 wk	<ul style="list-style-type: none"> • Gait velocity • Stride length • Cadence • Symmetry 	3 wk
Van Vliet 2005 ⁴²	n = 120 Stroke rehabilitation ward Time since stroke (wk): 0 to 2 Age (yr): Bobath 73 (10), Other 75 (9)	Bobath (n = 60): Bobath method Comparison (n = 60): movement science-based therapy Both: same for both groups, treatment time was as long as participant required (median = 23 min)	<ul style="list-style-type: none"> • Rivermead Motor Assessment • Motor Assessment Scale • 6MWT 	1 mth 3 mth 6 mth

(Continued on next page)

Table 1 (Continued)

Trial	Participants	Intervention	Activity level outcome measures	
			Measures	Times
Verma 2011 ⁴³	n = 30 Subacute phase Neurology department of a university hospital Inclusion criteria: acquire functional ambulation level ≥ 2 Time since stroke (wk): Bobath 7 (3), Other 6 (3) Age (yr): Bobath 55 (7), Other: 53 (9)	Bobath (n = 15): Bobath method. Time: 40 min, 7 d/wk for 2 wk Comparison (n = 15): motor imagery and task-oriented circuit class training program. Time: 15 min of motor imagery and 25 min of circuit class, 7 d/wk for 2 wk	<ul style="list-style-type: none"> • Functional Ambulation Classification • Rivermead Visual Gait Assessment • Gait parameters: step length asymmetry, stride asymmetry, cadence, comfortable vs max walking speed • 6MWT 	2 wk 6 wk
Wang 2005 ⁴⁴	Rehabilitation inpatient department n = 21 (participants with spasticity) Time since stroke (d): Bobath 22 (7), Other 21 (6) Age (yr): Bobath 54 (12), Other 59 (12) n = 23 (participants with relative recovery) Time since stroke (d): Bobath 22 (9), Other 20 (8) Age (yr): Bobath 62 (12), Other 64 (13)	Bobath (spasticity n = 10, relative recovery n = 11): Bobath method Comparison (spasticity n = 11, relative recovery n = 12): orthopaedic approach All: 40 min, 5/wk, 4 wk	<ul style="list-style-type: none"> • Motor Assessment Scale • Berg Balance Scale 	4 wk
Yagura 2006 ²⁸	n = 47 Inpatient rehabilitation hospital Inclusion criteria: non-ambulatory Time since stroke (d): Bobath 57 (11), Other 58 (24) Age (yr): Bobath 63 (7), Other 59 (6)	Bobath (n = 22): facilitation and bodyweight-supported treadmill training Comparison (n = 25): mechanical assistance + bodyweight-supported treadmill training Both: 20 min, 3 d/wk for 6 wk	<ul style="list-style-type: none"> • FIM • Walking speed 	6 wk 12 wk
Yelnik 2008 ⁴⁵	n = 68 Two rehabilitation centres Inclusion criteria: walk without human assistance Time since stroke (d): Bobath 218 (93), Other 217 (93) Age (yr): Bobath 55 (12), Other 56 (12)	Bobath (n = 35): NDT-based treatment Comparison (n = 33): multisensory balance training by training in sitting, standing and walking Both: 5 d/wk for 4 wk	<ul style="list-style-type: none"> • Berg Balance Scale • Posturographic limits of stability • % double-limb stance time • Comfortable walking speed • 10 steps and return • FIM 	30 d 90 d

COP = centre of pressure, CT = computed tomography, DEMMI = de Morton Mobility Index, EMG = electromyography, EQ-5D = EuroQoL questionnaire, FIM = Functional Independence Measure, LL FMA = lower limb section of the Fugl-Meyer Assessment, MAS = Motor Assessment Scale, MRI = magnetic resonance imaging, NDT = neurodevelopmental technique, OT = occupational therapy, PNF = proprioceptive neuromuscular facilitation, STS = sit to stand, TIS = Trunk Impairment Scale, TUG = Timed Up and Go test, 10mWT = 10-m walk test, 6MWT = six-minute walk test.

Table 2
PEDro scores of included studies.

Study	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	< 15% dropouts	Intention-to-treat analysis	Between-group difference reported	Point estimate and variability reported	Total (0 to 10)
Bale 2008 ³²	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Brock 2011 ³³	Y	Y	Y	N	N	Y	Y	N	Y	Y	7
Dias 2007 ²⁵	Y	N	Y	N	N	Y	N	N	N	Y	4
Dickstein 1986 ²⁶	Y	N	Y	N	N	N	N	Y	Y	N	3
Gelber 1995 ³⁴	Y	N	N	N	N	N	Y	N	Y	Y	4
Kılınc 2016 ³⁵	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Krukowska 2016 ³⁶	Y	N	N	N	N	N	Y	N	Y	Y	4
Krutulytė 2003 ²⁷	Y	N	Y	N	N	N	N	N	N	N	2
Langhammer 2000 ²⁹	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Langhammer 2003 ³⁰	Y	N	N	N	N	N	Y	N	Y	Y	4
Langhammer 2011 ³¹	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Mudie 2002 ³⁷	Y	Y	N	N	N	N	N	N	Y	Y	4
Mulder 1986 ³⁸	Y	N	N	N	N	N	Y	N	Y	Y	4
Richards 1993 ²⁴	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Simsek 2016 ³⁹	Y	Y	Y	N	N	Y	Y	N	Y	Y	7
Tang 2005 ⁴⁰	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Thaut 2007 ⁴¹	Y	Y	Y	N	N	Y	N	Y	Y	Y	7
Van Vliet 2005 ⁴²	Y	Y	Y	N	N	Y	N	Y	Y	Y	7
Verma 2011 ⁴³	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Wang 2005 ⁴⁴	Y	Y	Y	N	N	Y	Y	N	Y	Y	7
Yagura 2006 ²⁸	Y	Y	Y	N	N	N	Y	N	Y	Y	6
Yelnik 2008 ⁴⁵	Y	N	Y	N	N	Y	Y	Y	Y	Y	7

combined intervention was examined by pooling outcomes from four trials (mean PEDro score = 5.5) involving 98 participants (Figure 2, top). The SMD was -0.06 (95% CI -0.73 to 0.61 , $I^2 = 54\%$), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 3 on the eAddenda.

Walking

Twelve trials investigated the effect of Bobath therapy on walking. The effect of Bobath therapy on walking compared with task-specific training was examined by pooling outcomes from seven trials (mean PEDro score = 7) involving 409 participants (Figure 4, bottom). The SMD was 0.64 in favour of task-specific training, although the true size of the effect may be substantially smaller or larger (95% CI 0.06 to 1.21 , $I^2 = 86\%$). The effect of Bobath therapy compared with strength training was examined by pooling outcomes from two trials (mean PEDro score = 5.5) involving 30 participants (Figure 4, middle). The SMD was -0.07 (95% CI -0.80 to 0.66 , $I^2 = 0\%$), which did not provide clear evidence in favour of either intervention. The effect of Bobath therapy compared with a combined intervention was examined by pooling outcomes from three trials (mean PEDro score = 5.3) involving 49 participants (Figure 4, top). The SMD was -0.34 (95% CI -1.35 to 0.67 , $I^2 = 64\%$), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 5 on the eAddenda.

Standing balance

Eight trials investigated the effect of Bobath therapy on standing balance (Figure 6). The effect of Bobath therapy compared with task-specific training on standing balance was examined by pooling outcomes from three trials (mean PEDro score = 7) involving 155 participants (Figure 6, bottom). The SMD was 0.22 (95% CI -0.10 to 0.54 , $I^2 = 0\%$) in favour of task-specific training; however, the possibility of a small negative effect was not excluded. The effect of Bobath therapy compared with strength training was examined in one trial (PEDro score = 7) involving 18 participants (Figure 6, middle). The SMD was 0.34 (95% CI -0.59 to 1.28), which did not provide clear evidence in favour of either intervention. The effect of Bobath therapy compared with PNF was examined in one trial (PEDro score = 4) of 72 participants (Figure 6, middle). The SMD was -1.40 (95% CI -1.92 to -0.88) in favour of Bobath therapy. The effect of Bobath therapy compared with a combined intervention was examined by pooling outcomes from three trials (mean PEDro score = 6) involving 86 participants (Figure 6, top). The SMD was 0.10 (95% CI -0.33 to 0.53 , $I^2 = 0\%$); this

did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 7 on the eAddenda.

Sitting balance

Four trials investigated the effect of Bobath therapy on sitting balance (Figure 8). The effect of Bobath therapy compared with task-specific training on sitting balance was examined by pooling outcomes from three trials (mean PEDro score = 6) involving 200 participants (Figure 8, bottom). The SMD was 0.27 (95% CI -0.01 to 0.56 , $I^2 = 0\%$) in favour of task-specific training; however, the possibility of negligible difference between the interventions was not excluded. The effect of Bobath therapy compared with a combined intervention was examined in one trial (PEDro score = 6) involving 19 participants (Figure 8, top). The SMD was 0.22 (95% CI -0.68 to 1.12), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 9 on the eAddenda.

Sit-to-stand

Two trials (mean PEDro score = 7) investigated the effect of Bobath therapy compared with task-specific training on sit-to-stand, with a total of 160 participants (Figure 10). The SMD was 0.12 (95% CI -0.36 to 0.59 , $I^2 = 0\%$), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 11 on the eAddenda.

Stair climbing

Two trials (mean PEDro score = 7) investigated the effect of Bobath therapy compared with task-specific training on stair climbing, with a total of 129 participants (Figure 12). The SMD was 0.02 (95% CI -0.33 to 0.37 , $I^2 = 54\%$), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 13 on the eAddenda.

Mobility

Six trials investigated the effect of Bobath therapy on mobility as measured by a scale covering more than one lower limb activity, for example walking and sit-to-stand (Figure 14). The effect of Bobath therapy compared with task-specific training on mobility was examined by pooling outcomes from four trials (mean PEDro score = 6.5) involving 245 participants (Figure 14, bottom). The SMD was 0.40 (95% CI -0.13 to 0.93 , $I^2 = 75\%$) in favour of task-specific training, although the estimate was imprecise. The effect of Bobath therapy compared with a combined intervention was examined in two trials (mean PEDro score = 6) involving 63 participants (Figure 14, top). The

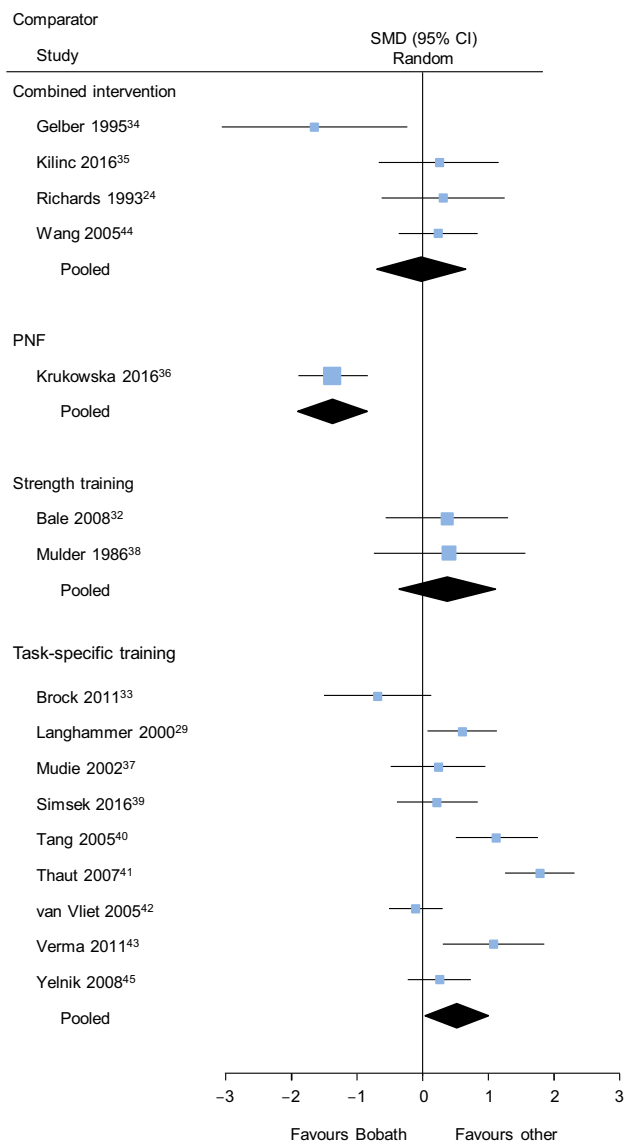


Figure 2. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on lower limb activity. PNF = proprioceptive neuromuscular facilitation.

SMD was -0.22 (95% CI -0.72 to 0.27), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 15 on the eAddenda.

Secondary outcome measures

Varied lower limb strength measures were reported, including isometric muscle strength and rating scales such as the Stroke Rehabilitation Assessment of Movement (STREAM). No trials reported an outcome measure that measured co-ordination alone. However, two trials reported an outcome measure that measures both strength and co-ordination (eg, the Fugl-Meyer lower extremity scale). Therefore, strength and co-ordination were reported in the same analysis. For the analysis of lower limb strength and co-ordination there were seven trials and three comparison interventions. The effect of Bobath therapy compared with task training was examined in four trials (mean PEDro score = 6.3) involving 222 participants (Figure 16, bottom). The SMD was 0.33 (95% CI -0.21 to 0.86 , $I^2 = 71\%$), which did not provide clear evidence in favour of either intervention. The effect of Bobath therapy compared with strength training was examined in one trial (PEDro score = 7) involving 18 participants (Figure 16, middle). The SMD was -0.06 (95% CI -0.99 to 0.87), which did not provide clear evidence in favour of either intervention. The effect of Bobath therapy compared with a combined intervention was examined in two trials (mean PEDro score = 6)

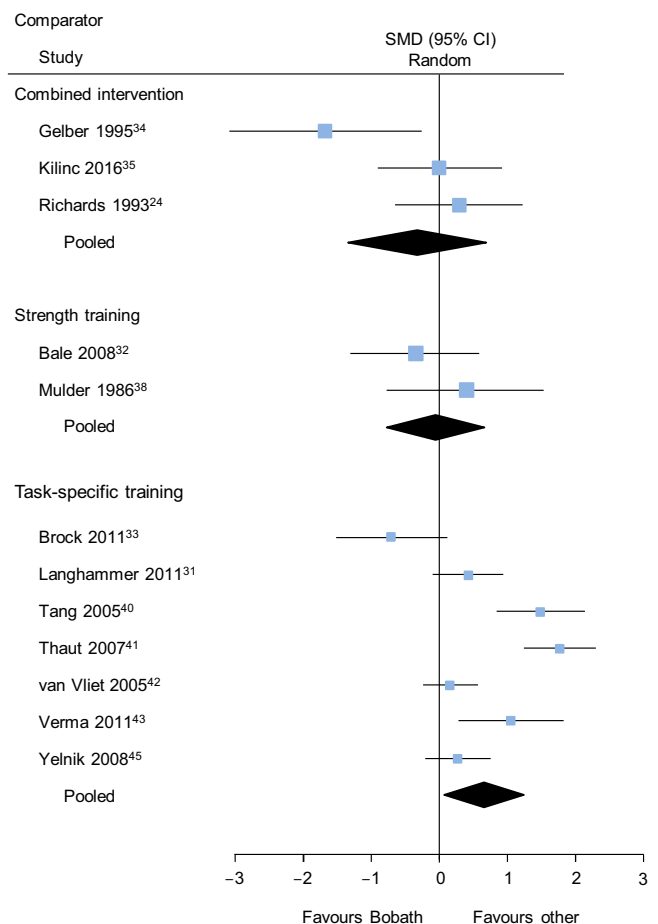


Figure 4. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on walking.

involving 63 participants (Figure 16, top). The SMD was -0.07 (95% CI -0.56 to 0.43 , $I^2 = 0\%$), which did not provide clear evidence in favour of either intervention. For a detailed forest plot, see Figure 17 on the eAddenda.

Trials that could not be meta-analysed

Two trials that could not be meta-analysed compared Bobath therapy with robotics. Firstly, Dias et al included 40 participants (PEDro score = 4) allocated to two groups: mechanical gait training or Bobath therapy.²⁵ The outcome measures of walking were the Rivermead Mobility Index (RMI) and 10-m walk test. The authors state that there was no significant difference in walking outcomes between the two groups. Secondly, Yagura et al included 49 participants (PEDro score = 6) allocated to two groups: treadmill walking with a robotic device or treadmill walking with Bobath therapy.²⁸ The outcome measure of walking was measured by 10-m walk test. There was no significant difference in walking outcomes between the two groups.

Dickstein et al included 196 participants (PEDro score = 3) allocated to three groups: conventional exercise, PNF or Bobath therapy.²⁶ The outcome measure of mobility was a 4-point scale, ranking on aids or assistance needed to walk. This mobility outcome did not differ significantly between the Bobath therapy and either of the other interventions. Similarly, the three interventions did not differ significantly in their effects on function, strength or range of motion.²⁶

Krutulyte et al included 240 participants (PEDro score = 2) allocated to two groups: Motor Relearning Program or Bobath therapy.²⁷ The outcome measure of walking was the European Federation for Research in Rehabilitation scale. There was no significant between-group difference in walking outcomes.

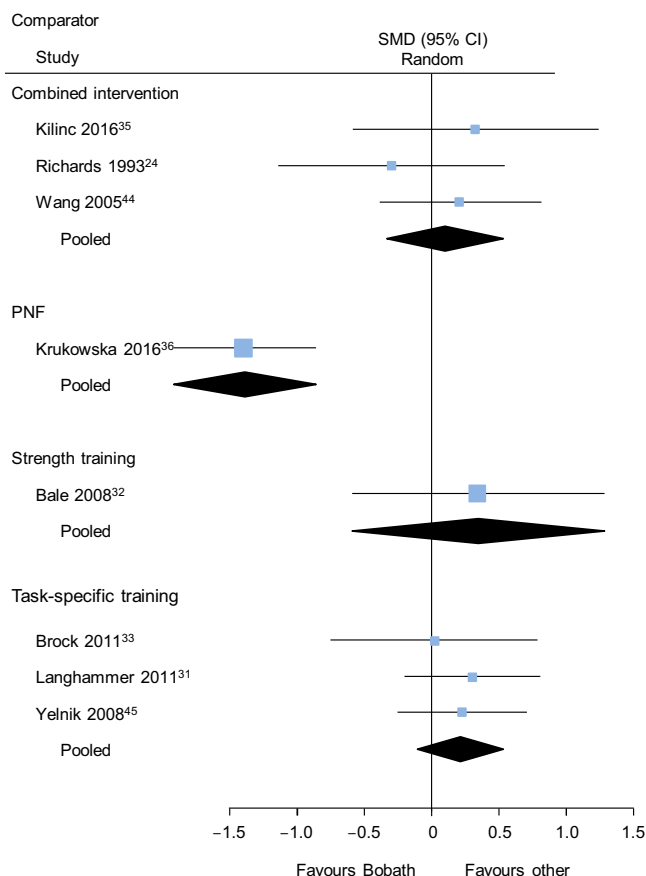


Figure 6. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on standing balance. PNF = proprioceptive neuromuscular facilitation.

Langhammer et al's publication³⁰ from 2003 (PEDro score = 4) reported 4-year outcomes for 37 participants from their original trial comparing Bobath therapy to the Motor Relearning Program.²⁹ The outcome measure of lower limb activity is the average Motor Assessment Scale score. There was no significant between-group difference in lower limb activity outcomes.

Discussion

This review found no trials to establish whether Bobath therapy has any benefit over no intervention for lower limb activity

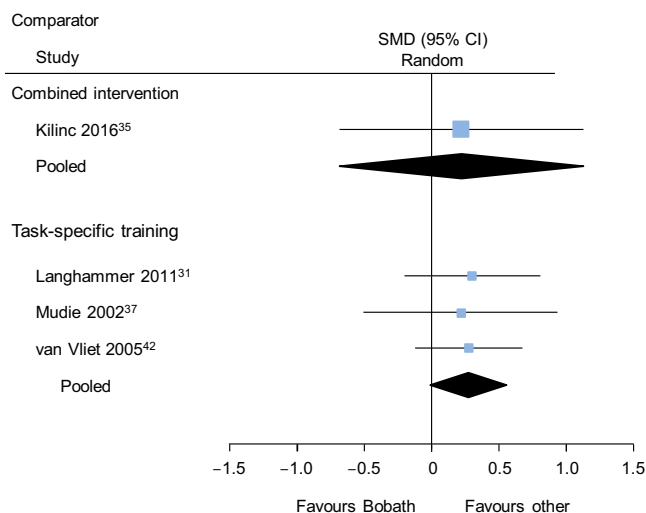


Figure 8. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on sitting balance.

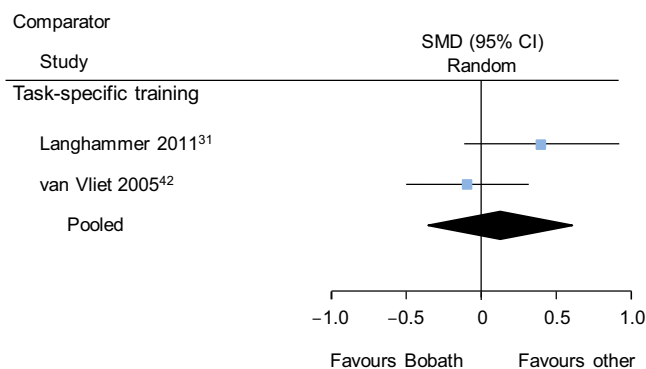


Figure 10. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on sit-to-stand.

performance after stroke. This review also found that Bobath therapy generally does not clearly improve lower limb activity performance compared with other interventions. Furthermore, Bobath therapy was less effective than task-specific training in improving lower limb activities in general and walking outcomes specifically, although it was unclear whether Bobath was less effective by a small or large amount. Although Bobath therapy was generally similar or worse than other interventions for lower limb outcomes, one trial reported that Bobath therapy was more effective than PNF for standing balance.³⁶ However, another trial identified no significant difference between Bobath therapy and PNF in function, strength, range of motion or walking.²⁶

It should be noted that the findings in this review where Bobath was less effective than another intervention (ie, task-specific training) were based on: pooling of data from 487 participants in nine trials (mean PEDro score 6.6) for lower limb activity measures; and pooling of data from 409 participants in seven trials (mean PEDro score 7.0) for walking measures. In contrast, the finding where Bobath was more effective than another intervention (ie, PNF) was based on an unreplicated study with 72 participants and much lower methodological quality (PEDro score 4).

There is now a large body of evidence to guide rehabilitation interventions following stroke.⁴⁶ Clinical guidelines for stroke rehabilitation now universally recommend intensive task-specific training.⁴⁶ No clinical guidelines recommend the use of Bobath therapy.⁴⁶ Previous systematic reviews have reported no difference in balance or walking outcomes for Bobath therapy compared with other interventions or that task-specific training is more effective than Bobath therapy.¹¹⁻¹⁴ These previous reviews included relatively low numbers of trials, with small sample sizes. However, we were able to include 17 trials in the current meta-analyses. This enabled confidence in the results shown in this review.

The results of this review provide additional support for the use of task-specific interventions to improve lower limb activities, particularly walking. The outcomes for lower limb activities are greatest

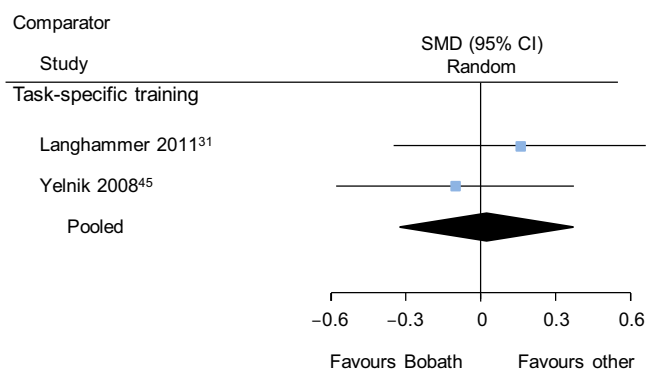


Figure 12. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on stair climbing.

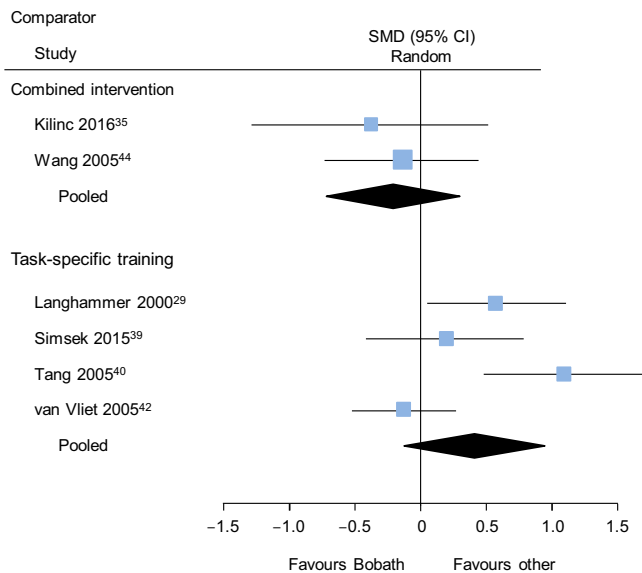


Figure 14. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on mobility.

when task-specific training is performed at higher intensities.^{46,47} Bobath therapy is not conducive to intensive task-specific and context-specific training as it has a central premise that therapists need to facilitate normal movement to enable a stroke survivor to optimise their task performance.⁴⁸ The results of this review challenge the prioritisation of Bobath therapy over other interventions for people with stroke.

A limitation of the trials included in this review is the lack of clarity in the definition of Bobath therapy and the variable methodological quality. Bobath therapy is said to have evolved over time, meaning it has been revised by others in the decades after the originators' deaths.^{7-9,48} For example, some Bobath interventions included in this review also incorporated aspects of structured task practice within the Bobath therapy.³³ As Bobath therapy is an approach to therapy rather than one discrete intervention, it is

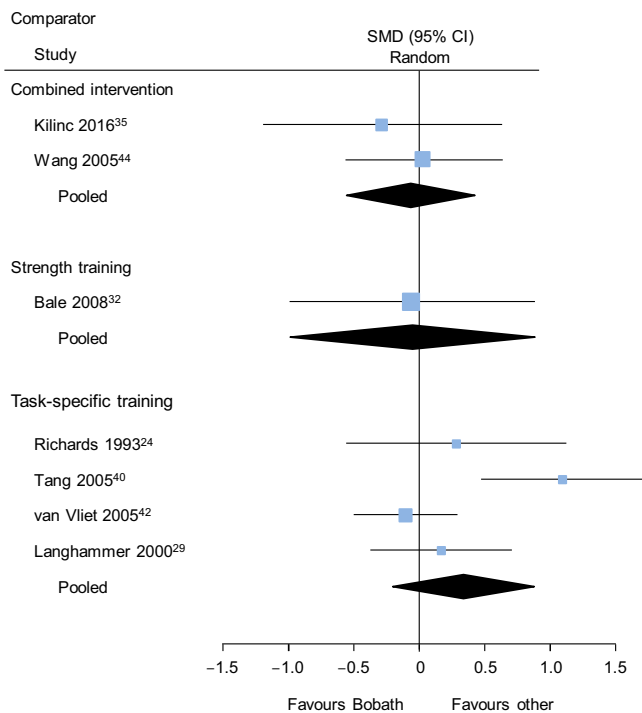


Figure 16. Standardised mean difference (95% CI) of the effect of Bobath therapy versus other intervention on lower limb strength and co-ordination.

difficult to standardise the interventions. However, an intervention called Bobath therapy must reflect the Bobaths' ideas and involve facilitation and inhibition carried out by a therapist – methods that are not congruent with recent developments in neuroscience and motor learning. This is further complicated in these trials by the fact that the Bobath therapy was often the 'conventional therapy' being used for the control group in the trial; hence, the descriptions of the Bobath therapy were limited. The trials included in the systematic review were published between 1986 and 2016; this variety in the year of publication likely contributed to the variable quality of the trials. The quality of trials included in this systematic review varied between 2 and 8 on the PEDro scale, raising questions around the internal validity of these trials.

A strength of this review was the comprehensive search of current literature. The search also included trials written in languages other than English, hence improving generalisability of results. This is also the first large systematic review to perform meta-analyses to investigate the effectiveness of Bobath therapy on lower limb activity and key impairments after stroke.

In conclusion, this review provides evidence that Bobath therapy is inferior to task-specific training for improving walking and lower limb activity outcomes after stroke. Additionally, Bobath therapy is generally not superior to other interventions. One exception was that Bobath therapy improved standing balance more than PNF in one trial, but these two therapies did not substantially differ on a range of other outcomes. Overall, choosing Bobath therapy over other interventions is not supported by current evidence. These results should not be surprising. Bobath therapy as developed by the Bobaths was based on the scientific knowledge of the 1950s and earlier. Modern neurorehabilitation is based on a current understanding of the neurosciences and biomechanics.

What is already known on this topic: Physiotherapy said to be based on Bobath therapy is widely used in clinical practice, despite a growing body of evidence that has challenged its underlying beliefs.

What this study adds: This review shows that task-specific training is more effective than Bobath therapy for improving walking and lower limb activity outcomes after stroke. It challenges the prioritisation of Bobath therapy in stroke rehabilitation.

eAddenda: Figures 3, 5, 7, 9, 11, 13, 15, 17 and Appendices 1 and 2 can be found online at DOI: <https://doi.org/10.1016/j.jphys.2020.09.008>.

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Correspondence: Katharine Scrivener, Department of Health Professions, Macquarie University, Sydney, Australia. Email: kate.scrivener@mq.edu.au

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