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Review Article

Effectiveness of Ankle-Foot Orthoses Combined with Physiotherapy on Gross Motor Function in Children with Spastic Cerebral Palsy: A Systematic Review and Meta-Analysis

Fazli Azim[1], Marya Lucky[2], Rao Muhammad Usman[3], Quratulain[4], Syed Raheel Mobin Jillani[5], Fawad Hafeez Qazi[2]

[1] Senior Lecturer, Sindh Institute of Physical Medicine and Rehabilitation, Pakistan
[2] Lecturer, Sindh Institute of Physical Medicine and Rehabilitation
[3] Lecturer, Prosthetist & Orthotist, Sindh Institute of Physical Medicine and Rehabilitation
[4] Instructor Physiotherapy, The Hunar Foundation
[5] Prostatist & Orthotist, Sindh Institute of Physical Medicine and Rehabilitation.

✉ **Correspondence:** Fazli Azim, fazliazim75@gmail.com

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ABSTRACT

Background: Ankle-foot orthoses (AFOs) are used alongside physiotherapy in children with spastic cerebral palsy, but their additional contribution to rehabilitation outcomes remains uncertain. Objective: To evaluate evidence addressing combined AFO–physiotherapy treatment through a systematic review and meta-analysis focused on gross motor function and related outcomes. Methods: The manuscript reports searches of PubMed/MEDLINE, Scopus, Web of Science, PEDro, Embase, CINAHL, and the Cochrane Library for English-language controlled studies. Eligibility required spastic cerebral palsy, a relevant physiotherapy component, and extractable gross motor outcomes. Independent screening and extraction, RoB 2 assessment, GRADE evaluation, and quantitative or narrative synthesis were described; supporting search records and appraisal results were not supplied. Results: The reported evidence comprised 32 articles involving 544 children and 56 comparisons, with 884 repeated participant contributions. These totals and pooled estimates corresponded to a previously published review predominantly comparing AFO-on with AFO-off conditions. Reported effects favored AFO use for GMFM standing (SMD 0.30; 95% CI 0.10–0.51; I^2=26%) and walking, running, and jumping (SMD 0.24; 95% CI 0.04–0.45; I^2=0%). Gait speed increased (SMD 0.28; 95% CI 0.14–0.41; I^2=76%), whereas oxygen consumption showed no significant difference (SMD 0.00; 95% CI −0.23–0.23; I^2=52%). Formal evidence certainty could not be established. Conclusion: The assembled evidence suggests selected biomechanical and functional benefits during AFO use but does not establish superiority of combined AFO–physiotherapy treatment over physiotherapy alone. Direct comparative evidence and independently documented review procedures are required. Keywords: Cerebral Palsy; Child; Orthotic Devices; Physical Therapy Modalities; Motor Skills; Gait; Systematic Review; Meta-Analysis.

INTRODUCTION

Children with spastic cerebral palsy experience limitations in movement and functional mobility that make standing and walking important targets of rehabilitation. Ankle-foot orthoses (AFOs) are used to support lower-limb alignment and modify gait mechanics, but the clinical value of an orthotic intervention depends on whether these changes translate into meaningful improvements in motor function. Existing reviews have examined effects across gait parameters, balance, and functional measures, highlighting the importance of assessing outcomes beyond ankle positioning alone (1).

Physiotherapy and orthotic management address potentially complementary aspects of rehabilitation. Physiotherapy provides opportunities to practise functional activities, while AFOs modify the mechanical conditions under which those activities are performed. Their combined use therefore has a plausible therapeutic rationale, but complementary mechanisms do not establish an additional treatment benefit. Improvements observed while a child wears an orthosis may represent an immediate assistive effect rather than a sustained improvement attributable to an AFO–physiotherapy programme. This distinction is essential when interpreting evidence about orthoses and when defining the comparison needed to evaluate combined treatment.

Previous evidence syntheses provide a foundation for examining this question. Lintanf et al. evaluated AFO effects on gait, balance, gross motor function, and activities of daily living, reporting improvements in selected gait and functional outcomes while identifying more limited evidence for balance and daily activities (1). Aboutorabi et al. similarly examined different AFO designs and described variation in outcomes alongside limitations in the methodological quality of the available studies (2). These findings support further evaluation of orthotic management, but they do not establish that adding AFOs to physiotherapy produces greater improvement than a comparable physiotherapy programme alone. Evidence concerning the effect of wearing an orthosis must therefore be distinguished from evidence concerning the effectiveness of a combined rehabilitation programme.

Interpretation is further complicated by variation in the interventions themselves. Orthoses differ in their design and mechanical characteristics, and broad device labels may conceal differences relevant to their clinical effects. Eddison et al. identified inadequate reporting of AFO design and material characteristics, limiting the reproducibility and interpretation of orthotic research (3). For a review of combined treatment, comparable attention is needed for the physiotherapy component, including its content, frequency, session duration, supervision, and relationship to orthosis use. Without this information, an apparent difference between treatment groups may be difficult to attribute to the orthosis, the rehabilitation programme, or differences in overall treatment exposure.

The principal unresolved question is therefore the incremental benefit of combined management under clearly defined treatment conditions. AFOs plus physiotherapy compared with physiotherapy alone addresses the additional contribution of orthotic support; comparison with AFOs alone addresses the additional contribution of physiotherapy. Comparisons with standard care require separate interpretation because the content of standard care may vary. Similarly, immediate changes during orthosis-assisted testing should be distinguished from outcomes measured after a period of rehabilitation. A synthesis that combines these comparisons without preserving their differences risks producing an effect estimate that does not answer a specific clinical question.

A focused systematic review is justified by the need to identify which studies directly evaluate combined AFO–physiotherapy treatment, assess their risk of bias, and determine whether their findings support clinically meaningful improvements in gross motor function. The contribution of such a review lies in clarifying the treatment contrast and the directness of the evidence, rather than repeating a broad assessment of AFO effects on gait. Quantitative synthesis may improve precision when studies address sufficiently comparable populations, interventions, comparators, outcomes, and assessment periods. Where these conditions are not met, a structured synthesis should preserve the differences between studies and make the remaining uncertainty explicit.

Accordingly, this review aims to evaluate the effectiveness of AFOs used in conjunction with physiotherapy in children with spastic cerebral palsy, compared with physiotherapy alone, orthotic intervention alone, or clearly described standard care. The primary outcome is gross motor function assessed using the Gross Motor Function Measure, with GMFM-66, GMFM-88 total scores, and individual dimensions distinguished during synthesis. Secondary outcomes include gait performance, balance, functional mobility, walking endurance, energy

expenditure, and quality of life. The review question is: in children with spastic cerebral palsy, does combined AFO–physiotherapy treatment improve gross motor function and related functional outcomes compared with these alternative management approaches, and how certain is the evidence for each comparison?

MATERIAL AND METHODS

The review was designed as a systematic review with meta-analysis to evaluate the effectiveness of ankle-foot orthoses (AFOs) combined with physiotherapy in children with spastic cerebral palsy. The methodological scope was defined by the population, intervention, comparator, and outcome framework, with particular emphasis on gross motor function and related functional outcomes. PRISMA 2020 provided the reporting framework (4).

Eligible studies involved children with a clinical diagnosis of spastic cerebral palsy, irrespective of topographical distribution, and evaluated AFOs used concurrently or sequentially with physiotherapy. Eligible comparators comprised physiotherapy alone, orthotic intervention alone, or standard care. Randomized controlled trials, controlled clinical trials, and quasi-experimental studies were considered. Studies were required to report extractable gross motor function outcomes measured using a standardized, validated instrument. Eligibility was restricted to English-language full-text reports. Studies involving adults or mixed adult–paediatric populations without separately extractable paediatric data were excluded. Studies evaluating orthotic management without a physiotherapy component relevant to the review question, studies lacking extractable gross motor function data, and reports that remained inaccessible despite author contact were also excluded.

The primary outcome was gross motor function assessed using the Gross Motor Function Measure, including GMFM-66 and GMFM-88 outcomes. Secondary outcomes comprised gait speed, cadence, stride length, walking endurance, balance, functional mobility, energy expenditure, and quality of life. Outcome instruments and assessment time points were recorded to characterize the functional domains evaluated and the timing of treatment effects.

Electronic searches covered PubMed/MEDLINE, Scopus, Web of Science, PEDro, Embase, CINAHL, and the Cochrane Library. Two reviewers independently screened studies for eligibility against the review criteria. Literature selection focused on controlled evaluations of AFO–physiotherapy management in the target population rather than studies addressing orthotic biomechanics without a relevant rehabilitation component.

Data were extracted independently by two reviewers using a standardized, piloted extraction form. Extracted information included author names, publication year, country, study design, sample size, age, sex distribution, cerebral palsy subtype and topography, and Gross Motor Function Classification System level. Intervention data included AFO design, material, hinge characteristics, prescribed wear schedule, duration of use, and the type and dosage of physiotherapy. Physiotherapy dosage was characterized through treatment frequency, session duration, and total intervention period. Comparator characteristics, outcome instruments, and baseline, post-intervention, and follow-up assessments were also recorded. Quantitative extraction included means, standard deviations, reported effect estimates, confidence intervals, and p-values. Disagreements in extraction were resolved through consensus or adjudication by a third reviewer.

The Cochrane Risk of Bias 2 tool was specified for assessing randomized trial evidence. Certainty of evidence was considered separately from the appraisal of individual studies using the Grading of Recommendations Assessment, Development and Evaluation approach. The assessment addressed risk of bias, inconsistency, indirectness, imprecision, and publication bias, with outcome-level certainty categorized as high, moderate, low, or very low.

The synthesis approach incorporated descriptive comparison of study populations, interventions, comparators, outcome measures, and assessment periods. Where quantitative pooling was not feasible because of clinical or methodological differences, findings were synthesized narratively and presented alongside study characteristics. Meta-analysis was considered where at least two studies provided sufficiently comparable quantitative outcomes. Continuous outcomes were expressed as mean differences when measured on the same scale or standardized mean differences when different scales assessed a comparable construct, accompanied by 95% confidence intervals.

The review used previously published data and did not involve direct recruitment or collection of new participant-level observations.

RESULTS

The supplied report identifies 32 included articles contributing 56 comparisons or sub-studies, of which 35 contributed to quantitative synthesis and 21 were described narratively. The available selection information begins at inclusion and therefore does not establish the preceding identification, deduplication, screening, or full-text exclusion stages. Across the articles, 544 children were reported, with a mean age of 7.9 ± 2.1 years. The larger total of 884 represents participant contributions across sub-studies and should not be interpreted as the number of unique children. These distinctions are summarized in Table 1.

The study characteristics in Table 2 show considerable variation in age, CP distribution, gait pattern, orthotic design, and assessment period. Most listed populations had spastic CP, although mixed or unspecified motor types also occurred. The manuscript describes the studies collectively as within-subject evaluations in which children were assessed with and without orthotic support. Control conditions were generally barefoot or shoes only, and assessment periods ranged from test-day evaluations to several months. The table does not establish a consistently defined physiotherapy intervention or a physiotherapy-only comparison group.

Table 1. Reported evidence-selection totals and population characteristics

Element	Reported value	Interpretation
Articles included	32	Published reports
Comparisons/sub-studies included	56	Not necessarily independent studies
Comparisons included in quantitative synthesis	35	May contribute to different outcome analyses
Comparisons described narratively	21	Not included in quantitative pooling
Children counted across articles	544	Reported participant count before repeated sub-study contributions
Participant contributions across sub-studies	884	Must not be described as 884 unique children
Mean age	7.9 years	Reported overall mean
Age SD	2.1 years	Reported overall SD
Bilateral CP comparisons	30	Reported laterality category
Unilateral CP comparisons	18	Reported laterality category
Mixed unilateral/bilateral comparisons	7	These three categories do not account for all 56 comparisons
Dynamic AFO comparisons	10	Reported orthosis category
Hinged AFO comparisons	18	Reported orthosis category
Solid AFO comparisons	11	Reported orthosis category
Supra-malleolar orthosis comparisons	5	Reported orthosis category
Ventral-shell AFO comparisons	2	Reported orthosis category
Comparisons evaluating participants' own AFOs	9	Device characteristics varied
Overall comparison design	Within-subject	Children served as their own controls
Control conditions	Barefoot, shoes only, or both	Not equivalent to a defined physiotherapy-only programme

The supplied manuscript does not establish initial search yields, duplicate removals, screening exclusions, or full-text exclusion counts. Consequently, a complete PRISMA flow cannot be reconstructed from these totals.

Table 2. Characteristics of the studies listed in the supplied manuscript

Study	Children, n (male/female)	Age, years, mean ± SD	CP distribution; gait pattern	GMFCS	Orthosis	Control	Reported testing/exposure period	Outcomes
Mossberg et al., 1990	18 (10/8)	8.3 ± 2.8	Bilateral spastic; unspecified gait	—	Own AFO	Barefoot	Test day	Energy cost
Radtka et al., 1997	10 (6/4)	6.5 ± 1.9	Unilateral/bilateral spastic; equinus	—	SAFO; SMO	Barefoot	1 month	Spatiotemporal measures, kinematics, EMG
Carlson et al., 1997	11 (6/5)	6.9 ± 0.7	Bilateral spastic; equinus/crouch	—	SAFO; SMO	Shoes	4 months	Spatiotemporal measures, kinematics, kinetics
Brunner et al., 1998	14 (6/8)	—	Unilateral spastic	—	SAFO; HAFO	Barefoot	Test day	Spatiotemporal measures, kinematics, kinetics

Study	Children, n (male/female)	Age, years, mean ± SD	CP distribution; gait pattern	GMFCS	Orthosis	Control	Reported testing/exposure period	Outcomes
Rethlefsen et al., 1999	21 (13/8)	9.1 ± 2.2	Bilateral spastic	—	SAFO; HAFO	Shoes	4–6 weeks	Kinematics, EMG
Crenshaw et al., 2000	8 (5/3)	8.4 ± 1.9	Bilateral spastic	—	Two HAFO designs; SMO	Shoes	4 weeks	Spatiotemporal measures, kinematics, kinetics
Maltais et al., 2001	10 (8/2)	9.0 ± 2.1	Bilateral spastic	I: 9; II: 1	HAFO	Shoes	4–6 weeks	Energy cost, functional outcomes
Buckon et al., 2001	30 (21/9)	—	Unilateral spastic	—	SAFO; HAFO; DAFO	Shoes	3 months	Spatiotemporal measures, kinematics, kinetics, energy cost, function
Dursun et al., 2002	24 (10/14)	6.7 ± 0.7	Unilateral/bilateral spastic; equinus	—	Own AFO	Barefoot	Test day	Spatiotemporal measures
Smiley et al., 2002	14 (8/6)	—	Bilateral spastic	—	SAFO; HAFO; DAFO	Shoes	Test day	Spatiotemporal measures, kinematics, energy cost
Buckon et al., 2004	16 (10/6)	8.4 ± 2.3	Bilateral spastic	I: 4; II: 12	SAFO; HAFO; DAFO	Shoes	3 months	Spatiotemporal measures, kinematics, kinetics, energy cost, function
Lam et al., 2005	13 (7/6)	5.9 ± 1.8	Bilateral spastic; equinus	—	SAFO; SMO	Barefoot	Test day	Spatiotemporal measures, kinematics, kinetics, EMG
Radtka et al., 2005	12 (6/6)	7.5 ± 3.8	Bilateral spastic; equinus	—	SAFO; HAFO	Barefoot	2 weeks	Spatiotemporal measures, kinematics, kinetics, EMG
Desloovere et al., 2006	—	5.86 ± 1.8	Unilateral spastic; equinus	—	Two DAFO designs	Barefoot and shoes	Test day	Spatiotemporal measures, kinematics, kinetics
Bjornson et al., 2006	—	4.3 ± 1.5	Spastic; laterality unspecified	I–III	SMO	—	Test day	Functional outcomes
Romkes et al., 2006	10 (4/6)	9.7 ± 1.6	Unilateral spastic; equinus	I: 8; II: 2	HAFO	Barefoot	Test day	Spatiotemporal measures, kinematics, EMG
Balaban et al., 2007	11 (7/4)	7.2 ± 1.2	Unilateral spastic; equinus	—	HAFO	Barefoot	Test day	Spatiotemporal measures, kinematics, kinetics, energy cost
Smith et al., 2009	—	7.5 ± 2.9	Bilateral spastic; jump gait	I: 15	HAFO; DAFO	Barefoot	4 weeks	Spatiotemporal measures, kinematics, kinetics, function
Vanwala et al., 2014	—	—	Unilateral/bilateral spastic	—	—	Barefoot	Test day	Spatiotemporal measures, energy cost
Kerkum et al., 2016	15 (11/4)	10.0 ± 2.0	Bilateral spastic; crouch	I: 2; II: 11; III: 2	VSAFO	Shoes	12–20 weeks	Spatiotemporal measures, kinetics, energy cost, daily activity
Bjornson et al., 2016	—	—	Bilateral; equinus/jump/crouch	I: 1; II: 9; III: 1	Own AFO	Shoes	4 weeks	Daily activity
Wren et al., 2015	10 (4/6)	7.5 ± 2.18	Unilateral/bilateral; equinus/crouch	I: 6; III: 4	DAFO; restricted HAFO	Barefoot	4 weeks	Spatiotemporal measures, kinematics, kinetics, centre-

Study	Children, n (male/female)	Age, years, mean ± SD	CP distribution; gait pattern	GMFCS	Orthosis	Control	Reported testing/exposure period	Outcomes
								of-pressure measures
Schmid et al., 2016	10 (9/1)	12.0 ± 1.4	Unilateral spastic	I: 9; II: 1	HAFO	Barefoot	Test day	Spatiotemporal measures, kinematics
Bhise Swati, 2017	—	10.0 ± 2.67	Bilateral spastic	—	Own AFO	Shoes	Test day	Spatiotemporal measures, energy cost
Tavernese et al., 2017: flexible-device subgroup	8 (4/4)	8.0 ± 2.2	Unilateral spastic; equinus/recurvatum/crouch	II: 8	Flexible DAFO/own AFO	Barefoot	Test day	Spatiotemporal measures, kinematics, kinetics
Tavernese et al., 2017: stiff-device subgroup	7 (4/3)	7.2 ± 2.2	Unilateral spastic; equinus/recurvatum/crouch	I: 4; II: 3	Stiff AFO/own AFO	Barefoot	Test day	Spatiotemporal measures, kinematics, kinetics
Galli et al., 2016: unilateral subgroup	11 (7/4)	Range: 4–13	Unilateral	I–II	Own SMO–HAFO	Barefoot	Test day	Gait profile and gait variable scores
Galli et al., 2016: mixed-laterality subgroup	10 (5/5)	Range: 5–14	Unilateral/bilateral	I–II	Own SMO–HAFO	Barefoot	Test day	Gait profile and gait variable scores
Rha et al., 2010	21 (11/10)	6.1 ± 1.1	Bilateral spastic; equinus	I: 4; II: 13; III: 4	HAFO	Barefoot	Test day	Standing centre-of-pressure velocity and displacement
Bahramizadeh et al., 2012	8 (2/6)	8.1 ± 2.4	Bilateral spastic; crouch	I–II	VSAFO	Barefoot	Test day	Standing centre-of-pressure velocity and displacement
Wilson et al., 1997	—	—	Bilateral spastic; equinus	—	SAFO; HAFO	Barefoot	Test day	Sit-to-stand timing and kinematics
Park et al., 2004	—	3.7 ± 1.1	Bilateral spastic	—	HAFO	Barefoot	Test day	Sit-to-stand timing, kinematics, kinetics
Kott and Held, 2002	28 (20/8)	10.6 ± 4.5	Spastic/ataxic; mixed distribution	I: 19; II: 9	Own AFO	—	Test day	Obstacle-crossing function
Sienko-Thomas et al., 2002	19 (11/8)	—	Unilateral spastic	—	SAFO; HAFO; DAFO	Barefoot	3 months	Stair-related spatiotemporal, kinematic, and functional outcomes

—: not recoverable from the supplied table. SAFO: solid AFO; HAFO: hinged AFO; DAFO: dynamic AFO; SMO: supramalleolar orthosis; VSAFO: ventral-shell AFO; EMG: electromyography; GMFCS: Gross Motor Function Classification System. Subgroups are retained as separate rows without assuming that they represent independent articles. The manuscript describes the studies collectively as within-subject evaluations; individual randomization status and physiotherapy dosage are not established.

Table 3. Complete pooled estimates reported in the supplied manuscript

Outcome	Reported comparisons, n	Reported participant contributions, n	Effect size, SMD	95% CI	I^2, %	p-value
GMFM dimension D: standing	9	188	0.30	0.10 to 0.51	26	0.004
GMFM dimension E: walking, running, jumping	9	188	0.24	0.04 to 0.45	0	0.020
PEDI mobility	6	135	0.57	0.33 to 0.81	0	<0.001
PODCI sports and physical function	2	30	0.91	0.36 to 1.46	81	0.001
PODCI transfers	2	30	0.20	−0.33 to 0.73	89	0.470
Gait speed	33	468	0.28	0.14 to 0.41	76	<0.001

Outcome	Reported comparisons, n	Reported participant contributions, n	Effect size, SMD	95% CI	I^2, %	p-value
Stride length	32	444	0.88	0.73 to 1.03	82	<0.001
Cadence	33	468	−0.72	−0.86 to −0.59	77	<0.001
Ankle dorsiflexion at initial contact	28	384	1.65	1.47 to 1.83	83	<0.001
Ankle dorsiflexion during swing	16	226	1.34	1.13 to 1.56	74	<0.001
Peak ankle power generation during stance	18	248	−0.72	−0.91 to −0.53	72	<0.001
Hip flexion at initial contact	12	110	0.33	0.06 to 0.60	0	0.020
Hip flexion during swing	5	50	0.15	−0.24 to 0.55	0	0.450
Hip extension	5	44	−0.03	−0.45 to 0.39	0	0.900
Knee flexion at initial contact	18	211	0.00	−0.20 to 0.19	53	0.980
Knee flexion during swing	14	181	0.09	−0.12 to 0.30	0	0.380
Knee extension during stance	8	103	−0.04	−0.31 to 0.23	0	0.770
Tibialis anterior activity during stance	4	44	0.11	−0.31 to 0.54	0	0.590
Oxygen consumption	7	146	0.00	−0.23 to 0.23	52	1.000

SMD: standardized mean difference; CI: confidence interval; GMFM: Gross Motor Function Measure; PEDI: Pediatric Evaluation of Disability Inventory; PODCI: Pediatric Outcomes Data Collection Instrument. Values are transcribed from the supplied manuscript, not recalculated. Positive and negative values indicate the direction of the measured change; they do not universally indicate benefit or harm. Counts must not be summed across outcomes because participants and comparisons overlap.

Table 4. Outcome coverage and qualitative synthesis

Domain	Reported comparisons/sub-studies	Reported findings	Quantitative reporting available
Level-ground gait	46	Longer strides, increased speed, and lower cadence in pooled analyses	Complete pooled estimates in Table 3
Functional scales	15	Improvements in GMFM D/E, PEDI mobility, and PODCI sports/physical function; no statistically significant PODCI transfer effect	Complete pooled estimates in Table 3
Standing balance	2	Standing postural-control findings were generally inconclusive; the narrative also describes a null pediatric balance-scale finding	No study-level estimates or exact p-values supplied
Sit-to-stand transfers	3	Two studies reportedly found shorter transfer times and altered kinematics	No effect estimates, CIs, or exact p-values supplied
Obstacle crossing	1	No statistically significant effect reported	No effect estimate, CI, or exact p-value supplied
Stair climbing/descent	3	No reduction in stair-climbing ability; improved foot-contact positioning during ascent reported	No effect estimates, CIs, or exact p-values supplied
Daily activity	2	No reported change in total daily strides or peak activity index	No effect estimates, CIs, or exact p-values supplied
Energy cost: non-pooled findings	Not separately specified	Findings varied, including reduced, unchanged, and increased energy cost	Overall pooled oxygen-consumption result in Table 3

Outcome categories overlap. “No statistically significant effect” does not establish equivalence or absence of a clinically relevant effect.

Table 6. Risk-of-bias, certainty, and robustness information available for reporting

Assessment	Information in the supplied manuscript	Reporting implication
RoB 2	Named in Methods; no study-level domain judgments supplied	Low-risk, some-concerns, and high-risk counts cannot be reported
GRADE	Named in Methods; no outcome-specific evidence profiles supplied	Formal certainty ratings cannot be assigned from the available material
Evidence-strength descriptions	Discussion labels gait evidence “strong,” gross motor evidence “moderate,” and balance/daily-activity evidence “low”	These are unsubstantiated narrative labels, not demonstrated GRADE assessments

Assessment	Information in the supplied manuscript	Reporting implication
Publication bias	Narrative states that funnel plots showed no evidence of bias	Plot-specific study counts and assessable figures are not supplied
Sensitivity analyses	No numerical findings supplied	Robustness to analysis choices cannot be reported
Repeated comparisons	Multiple sub-studies from the same articles were counted separately	Independence assumptions and participant weighting require verification
Orthosis reporting	Incomplete stiffness, ankle-angle, and material descriptions noted	Limits device-specific interpretation
Sample-size planning	Narrative states that only one study reported a formal sample-size/power calculation	Study-level verification is required

Study-level risk-of-bias findings and outcome-specific GRADE judgments are not available for presentation. Although the Methods name RoB 2 and GRADE, the supplied Results do not provide domain judgments, supporting explanations, or certainty profiles. Consequently, the qualitative strength labels used in the Discussion cannot be treated as verified certainty assessments. Table 6 separates the reported methodological statements from the assessment findings needed to substantiate them.

For gross motor function, the reported pooled estimate for GMFM dimension D was SMD 0.30 (95% CI 0.10–0.51; I^2 = 26%; p = 0.004), and that for dimension E was SMD 0.24 (95% CI 0.04–0.45; I^2 = 0%; p = 0.020). Each analysis contained nine reported comparisons and 188 participant contributions. PEDI mobility showed an SMD of 0.57 (95% CI 0.33–0.81; I^2 = 0%; p < 0.001). The PODCI sports and physical-function estimate was 0.91 (95% CI 0.36–1.46; I^2 = 81%; p = 0.001), whereas the transfer estimate was not statistically significant at 0.20 (95% CI −0.33 to 0.73; I^2 = 89%; p = 0.470). Table 3 presents the full numerical results.

For spatiotemporal gait outcomes, the reported estimates indicated increased stride length, SMD 0.88 (95% CI 0.73–1.03; I^2 = 82%; p < 0.001), and gait speed, SMD 0.28 (95% CI 0.14–0.41; I^2 = 76%; p < 0.001). Cadence decreased, with an SMD of −0.72 (95% CI −0.86 to −0.59; I^2 = 77%; p < 0.001). These statistically significant results were accompanied by substantial between-comparison heterogeneity.

The largest reported kinematic changes concerned ankle dorsiflexion. At initial contact, the pooled SMD was 1.65 (95% CI 1.47–1.83; I^2 = 83%; p < 0.001), and during swing it was 1.34 (95% CI 1.13–1.56; I^2 = 74%; p < 0.001). Peak ankle power generation during stance decreased, SMD −0.72 (95% CI −0.91 to −0.53; I^2 = 72%; p < 0.001). Hip flexion at initial contact increased, SMD 0.33 (95% CI 0.06–0.60; I^2 = 0%; p = 0.020). Other reported hip and knee outcomes and tibialis anterior activity did not reach statistical significance. Pooled oxygen consumption also showed no statistically significant difference, SMD 0.00 (95% CI −0.23 to 0.23; I^2 = 52%; p = 1.000).

Outcome coverage was concentrated on level-ground gait, reported in 46 sub-studies, compared with 15 addressing functional scales and substantially fewer addressing standing balance, transfers, obstacle crossing, stairs, or daily activity. The qualitative findings in Table 4 describe shorter sit-to-stand transfer times in two studies, inconclusive standing-balance findings, and no reported changes in daily stride totals or peak activity indices in two studies. Study-level estimates and exact inferential statistics were not supplied for these findings.

Orthosis-specific and laterality analyses were described qualitatively, including improvements in gait speed with hinged AFOs and larger reported changes in several outcomes among children with unilateral CP. However, subgroup effect estimates, confidence intervals, and interaction tests were not supplied. These descriptions are therefore retained in Table 5 without asserting comparative superiority. Similarly, the statement concerning absent funnel-plot evidence of publication bias cannot establish that reporting bias was absent, and no numerical sensitivity-analysis results are available.

DISCUSSION

The objective of this review was to evaluate whether AFOs combined with physiotherapy improve gross motor function and related outcomes in children with spastic cerebral palsy. The assembled evidence addresses this objective only indirectly. The reported comparisons predominantly evaluate performance with and without orthotic support rather than the incremental effect of adding AFOs to a defined physiotherapy programme. Within those comparisons, the findings indicate changes in ankle kinematics and spatiotemporal gait parameters alongside smaller improvements in selected gross motor outcomes. They do not establish that combined treatment is superior to physiotherapy alone, nor do they demonstrate that improvements observed during orthosis-assisted testing persist after a period of rehabilitation.

The relationship between biomechanical and functional findings is clinically relevant. The reported increases in ankle dorsiflexion and stride length coexist with smaller GMFM effects, reduced ankle power generation, and no statistically significant pooled change in oxygen consumption. This pattern suggests that changes in mechanical alignment should not be treated as substitutes for meaningful functional improvement. However, it does not establish that biomechanical changes cause the observed motor-function effects, because the outcomes were not necessarily evaluated in the same participants or under comparable treatment conditions. Differences between standardized effect sizes across distinct instruments also cannot be interpreted as direct differences in clinical importance.

The correspondence with Lintanf et al. requires particularly careful interpretation. The principal pooled estimates and evidence counts in the supplied synthesis correspond to that earlier review; agreement therefore reflects a shared evidence source rather than independent replication (1). The present presentation can clarify how effect magnitude, heterogeneity, and evidence volume relate across outcomes, but it does not demonstrate an updated evidence base. A defensible advance over previous reviews would require a documented search and selection process focused specifically on combined AFO–physiotherapy treatment, with explicit separation of immediate orthotic assistance from longer-term rehabilitation outcomes.

The broader literature summarized in the manuscript supports the need for this distinction. Aboutorabi et al. described variation in outcomes across AFO designs and limitations in the methodological quality of the available evidence (2). Such variation limits the interpretation of AFOs as a single, uniform intervention. Eddison et al. additionally identified insufficient reporting of orthosis design and material characteristics, which restricts reproducibility and makes it difficult to determine which device features account for observed effects (3). These concerns are directly relevant to combined treatment, where inadequate descriptions of both the orthosis and the physiotherapy programme can prevent attribution of any observed benefit to a specific component.

Heterogeneity was substantial for several prominent outcomes, including stride length, gait speed, and ankle dorsiflexion. Plausible contributors include differences in CP distribution, baseline gait pattern, functional ability, orthosis stiffness and configuration, footwear, accommodation periods, and assessment conditions. Test-day comparisons may capture an immediate mechanical response, whereas assessments after weeks or months may also reflect familiarity, adherence, growth, or other rehabilitation exposure. Pooling these circumstances can produce an average that has limited applicability to an individual child or treatment programme. These explanations remain hypotheses within the available synthesis because the supplied subgroup results do not quantify their contribution to between-study variation.

Lower heterogeneity for GMFM and PEDI outcomes should also be interpreted cautiously. An I^2 value of zero does not establish high certainty, particularly when the number of independent studies is limited or repeated comparisons contribute to the analysis. Conversely, the larger PODCI sports and physical-function estimate combines a small reported evidence base with substantial inconsistency. Its apparent magnitude therefore provides insufficient justification for expecting a large functional response in routine practice. Interpretation should consider the confidence interval, independence of contributing observations, outcome relevance, and risk of bias together, rather than prioritizing statistical significance.

The distinction between unique participants and repeated participant contributions is another important limitation. The manuscript reports 544 children across articles and 884 contributions after counting sub-studies separately. Multiple orthosis conditions or assessments from the same participants are correlated, and their inclusion requires an analysis that accommodates that dependence. Without adequate documentation of paired-data calculations and shared-participant handling, the precision of the pooled estimates cannot be confirmed. The reported confidence intervals should consequently be understood as transcribed results whose underlying assumptions remain unresolved, rather than independently validated measures of uncertainty.

Other limitations concern both eligibility and reporting. The stated review requires a relevant physiotherapy component and extractable gross motor function outcomes, yet several listed studies primarily address gait mechanics or energy cost. Mixed or unspecified CP populations further complicate applicability to children with spastic CP. The incomplete search documentation prevents assessment of coverage and recency, while the inconsistency between English-only eligibility and the English/French restriction described elsewhere leaves the selection process unclear. Study-level risk-of-bias judgments and outcome-specific GRADE profiles are also

absent. These gaps prevent a defensible certainty rating and cannot be resolved by interpreting small p-values as strong evidence.

The evidence distribution limits conclusions about everyday benefit. Level-ground gait dominates the reported literature, whereas balance, transfers, obstacle negotiation, and daily activity receive substantially less attention. An improvement during standardized walking assessment may therefore coexist with little measurable change in daily mobility or participation. Similarly, null findings in sparsely studied domains do not demonstrate equivalence or prove that AFOs offer no benefit. They identify outcomes for which the available evidence is insufficiently informative.

For clinical interpretation, the findings support linking orthotic assessment to clearly defined functional goals and evaluating whether device-related mechanical changes correspond to outcomes that matter to the child. They do not support a universal device preference, a claim that one CP subgroup benefits more than another, or a general recommendation that adding AFOs necessarily enhances physiotherapy outcomes. Service-level decisions should likewise avoid treating changes in gait kinematics alone as evidence of improved participation or independence. The present synthesis offers a rationale for more focused assessment rather than a definitive comparative treatment recommendation.

Future research should directly compare a clearly specified physiotherapy programme with the same programme plus AFOs, while documenting orthosis configuration, footwear, wear time, accommodation, adherence, and co-interventions. Trials should prespecify an appropriate gross motor outcome and include follow-up capable of distinguishing immediate assistance from sustained functional change. Daily mobility, participation, comfort, adverse effects, and treatment burden should complement laboratory gait measures. Subsequent reviews should distinguish independent studies from repeated comparisons, apply design-appropriate risk-of-bias assessment, and use formal interaction tests before making subgroup claims. These steps would address the central unresolved question: whether orthotic support adds a meaningful and sustained benefit to physiotherapy.

CONCLUSION

The reported evidence suggests that AFO use can alter ankle mechanics and gait performance and may improve selected gross motor outcomes in children with spastic cerebral palsy. These findings do not establish the additional benefit of combining AFOs with physiotherapy compared with physiotherapy alone, because the available comparisons predominantly concern performance with and without orthotic support. Clinical interpretation should therefore remain specific to the assessed outcome and treatment context. Direct comparative studies with standardized rehabilitation programmes, appropriate handling of repeated observations, and meaningful functional follow-up are needed to determine the effectiveness of combined management.

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