Received: 15 June 2023 | Revised: 10 June 2024 | Accepted: 11 June 2024

DOI: 10.1111/cch.13301

RESEARCH ARTICLE

WILEY

Effectiveness of therapeutic interventions on participation in children with cerebral palsy: A systematic review and meta-analysis

Rigas Dimakopoulos[1] | Theodora Vakalaki[1] | Arietta Spinou[2] | Ioannis Michopoulos[3] | Marianna Papadopoulou[1]

[1]Department of Physiotherapy, University of West Attica, Athens, Greece

[2]Population Health Sciences, Faculty of Life Sciences and Medicine, King's College London, London, UK

[3]Second Department of Psychiatry, Medical School, National and Kapodistrian University of Athens, Attikon University General Hospital, Athens, Greece

Correspondence
Rigas Dimakopoulos, Department of Physiotherapy, University of West Attica, Deliyanni 1, Athens, Greece.
Email: rigasd@yahoo.com

Funding information
No funding was received for this manuscript.

Abstract

Background: Participation in life activities is an integral part of health and a main outcome of rehabilitation services for children and adolescents with disabilities. However, there is still no consensus on the most effective way to improve participation. The aim of this systematic review is to determine the effectiveness of therapeutic interventions on participation outcomes of children with cerebral palsy (CP).

Methods: A systematic review was conducted, searching the databases PubMed, Cochrane Library, Science Direct, Web of Science and Scopus for randomized controlled trials (RCTs), between 2001 and 2023. Studies were eligible for inclusion if they evaluated children with CP undergoing any intervention and using any tool measuring participation as an outcome measure. A meta-analysis of treatment effect was conducted. A sensitivity analysis was conducted to identify the effect on participation when intervention targeted different International Classification of Functioning (ICF) domains.

Results: A total of 1572 records were identified. Eight RCTs including 384 children (195 in the intervention group and 189 in the control group) were included in the systematic review and in the meta-analysis. A sensitivity analysis showed that interventions focusing on participation significantly improved participation; standardized mean difference (1.83; 95% CI: 1.33–2.32; $Z = 7.21$; $P < 0.00001$). When other types of interventions, that is, focusing on body functions and structures or activities, were used, then participation was not favourably affected.

Interpretation: Interventions primarily targeting barriers to participation across several ICF domains have a greater influence on enhancing participation. Interventions aimed at enhancing specific motor skills, including gross and fine motor function or strength, do not necessarily have a positive impact on participation.

1 | INTRODUCTION

More than 20 years ago, the term participation was officially introduced by the International Classification of Functioning, Disability and Health, commonly known as ICF. Participation is defined as a person's 'involvement in a life situation' and represents the societal perspective of functioning (World Health Organization, 2001). However, with ageing, life situations change dramatically in number and complexity while they vary among individuals with different cultures, interests and preferences or in different contexts. In addition, the involvement in various activities is a matter of personal choice. This is essential for children and youth under the age of 18 years, as a child's functioning cannot be seen in isolation but rather as constantly dependent on the interaction with the surrounding environment, that is, with the family, caregivers and friends. Young children are more likely to participate in activities that are defined by adults, predominately parents, caregivers or service providers and are shaped by cultural norms and customs.

To address the complexity of participation and better describe its dimensions, Imms et al. (2017) introduced the family of participation-related constructs (fPRCs). According to the fPRCs, participation incorporates two basic elements: attendance and involvement. Attendance describes the situation of 'being there' and is commonly measured as the frequency of participation to an activity or the variety of activities in which someone participates. Involvement describes the 'experience' of participation while attending and is a more personal experience that includes the elements of motivation, persistence, effect and social connection.

Aligned with a more concrete understanding of participation comes the development of specific outcomes that measure it. Resch et al. (2020) identified 37 instruments developed to measure participation in children with cerebral palsy (CP) or acquired brain injury, 12 of which measured attendance and/or involvement. Despite having a more detailed conceptual description of participation and an array of measurement tools at our disposal, a significant portion of these tools still fall short in fully capturing all the elements it entails.

CP is the most common cause of physical disability in childhood (Reddihough, 2011). It refers to an umbrella term for a group of disorders of movement and posture, caused by a non-progressive interference in the developing brain with prevalence as high as 1.6 children per 1000 live births in the high-income countries and 3.4 children per 1000 live births in low and middle-income countries (McIntyre et al., 2022). Children with CP may experience spasticity, muscle weakness, reduced selective motor control and impaired fine and gross motor function (Sanger, 2015). Therefore, they show limitations in mobility and physical activity compared to their typically developing peers, and face more barriers to participating in life activities (Anaby et al., 2013; Bedell et al., 2013; Law et al., 2007).

However, the effect of the various therapeutic approaches in children with CP on participation is largely unknown. There are studies suggesting that interventions that focus on impairment, that is, target improvement at the body functions and structure or activities (motor skills), are insufficient to improve participation when used alone (Reedman, Boyd, & Sakzewski, 2017). However, participation-based therapies such as ParticiPAte CP (Reedman, Boyd, Elliott, & Sakzewski, 2017) and Pathways and Resources for Engagement and Participation (Anaby et al., 2018) aiming to enable participation through modifying the environment and utilizing personal factors may be more effective (Reedman, Boyd, & Sakzewski, 2017). Moreover, little is known about the transaction of changes among the ICF domains (Batorowicz et al., 2016), although many rehabilitation treatments are still applied in the hope that they can influence dimensions of functioning that are distal to the target of treatment (Whyte, 2014).

Key Messages

- Interventions designed to improve motor function do not necessarily improve participation.
- Interventions that primarily address barriers to participation across several ICF domains have a more substantial impact on enhancing participation.
- The choice of suitable outcome measures that align with the latest conceptual framework of participation may be more efficient in capturing changes in participation.

Previous systematic reviews have provided some evidence in this field. Bania et al. (2019) examined the effect of activity training on the ground versus activities initiated by machines, such as treadmills, or by animals or performed in the water; they found little effect on participation. Reedman et al. examined the efficacy of physical therapy and behaviour change interventions on habitual physical activity and on leisure-time physical activities. They reported a small effect on habitual physical activity (Reedman, Boyd, & Sakzewski, 2017). Kilgour et al. (2022) focused on the effect of physical activity interventions on attendance and involvement in physical activities and found only short-term improvements on physical activity attendance. Finally, 8 years ago, Adair et al. (2015) reviewed the effect of any intervention at improving participation outcomes but included studies targeting children with any kind of disability (motor disabilities, developmental disabilities, intellectual disability and communication disorders). This study concluded that interventions with primary focus on body functions and structures or activities did not influence participation.

This study aims to investigate the effect of any type of intervention, regardless of whether it targets body function and structure, participation or the contextual factors, on any dimension of participation of children with CP at home, at school or in the community. We hypothesized that different types of interventions would influence participation in different ways and that not all the validated outcome measures designed to capture participation would record intervention-induced changes in the same way.

2 | METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The protocol has been registered and published: https://doi.org/10.17605/OSF.IO/92ZTA.

2.1 | Literature search

A systematic literature search was conducted in December 2023. Searching databases were PubMed, Cochrane Library, Science Direct, Web of Science, Scopus, Embase and CINAHL. The literature search used the Medical Subject Headings (MeSH) and free-text words for ((((participation OR social participation OR leisure activities OR engagement OR involvement OR activities of daily living OR home participation OR community participation OR school participation OR sport participation)))) AND ((((cerebral palsy OR motor disability OR physical disability OR motor impairment OR special needs)))) AND ((((((intervention OR 'participation focused' OR 'participation based' OR 'participation therapy')))))). Search terms were combined by using Boolean operators (AND/OR). Example of the search strategy is included in Table S1.

Inclusion criteria:

- Only randomized control trials (RCTs), since they are considered to be the most reliable kind of clinical research and ensures that possible population biases are not a factor in the results. In the hierarchy of evidence, systematic reviews of randomized trials offer the highest level of evidence (Charrois, 2015).
- Publication date after 2001, which was the year of ICF publication (World Health Organization, 2001).
- Only full-text original articles published in indexed peer-review journals.
- Study group: children and youth (aged 2–18 years old) with a diagnosis of any type of CP (spastic, dyskinetic, ataxic, hypotonic, mixed types), with any level of Gross Motor Function Classification System (GMFCS).
- Control group should receive no intervention, placebo or usual care or be allocated in the waiting list.
- Intervention could be of any type, targeting any ICF domain, that is, Body Functions and Structures such as muscle strength, elasticity or aerobic capacity; Activities such as walking, running, cycling or any other kind of gross or fine motor skill; and Participation; environmental factors including environmental adaptations or special equipment; and personal factors including inspirational talks, education, personal interviews or motivational teams.
- Any aspect of participation could be assessed, addressing the more general definition of participation, that is, involvement in life situation.
- Assessment of participation could be in any environment, that is, school, home and community.
- Assessment of participation using any suitable and validated tool, designed to measure any aspect of participation, that is, frequency and/or involvement.
- Participation measurement could be a primary or secondary outcome measure.

Exclusion criteria:

- Studies were excluded if the control or intervention group received pharmacological or surgical treatment.

The reference lists of all the full-text appraised articles were screened for relevant citations that might have been missed from the electronic searches. Once all articles were identified, they were inserted in Rayyan software, a freely available software that can be used for the screening process, developed and published from Qatar Computing Research Institute and Cochrane Bahrain (Ouzzani et al., 2016). Duplicates were automatically removed. Two reviewers (RD, TV) independently screened the titles and abstracts for eligibility and then the full-text papers (Figure 1). In case of disagreement, a consensus was reached regarding the inclusion of each study or a third reviewer was consulted (MP).

2.2 | Data extraction

Two reviewers (RD, TV) independently extracted raw outcome data including authors, date of publication, sample size, intervention (type and protocol design), control treatment and outcome measures (participation scales) before and after the intervention, as well as participant characteristics such as age, sex, type of CP, GMFCS level and evaluation time. A third reviewer (MP) was involved in case of any disagreement.

2.3 | Risk of bias

Two reviewers (RD, TV) independently examined the risk of bias of the included studies using the PEDro scale (Cashin & McAuley, 2020). PEDro scale is widely used in the field of physical therapy (Armijo-Olivo et al., 2015), a field that is relevant to most included studies. The PEDro scale consists of 11 items encompassing external validity (item 1), internal validity (items 2–9) and statistical reporting (items 10 to 11). Items were rated as yes or no (1 or 0) according to whether the criterion is clearly satisfied. A total PEDro score was derived by adding the ratings of items 2–11 and had a range of 0–10. A total PEDro score of 8–10 is considered *excellent*, 6–8 *good*, 4–5 *fair* and 0–3 *poor*. During the exploration of risk of bias, there were no instances of disagreement among the reviewers.

2.3.1 | Data synthesis and statistical meta-analysis

MetaView Review Manager version 5.4 was used (RevMan, n.d.). To analyse the effect of the identified interventions on participation on

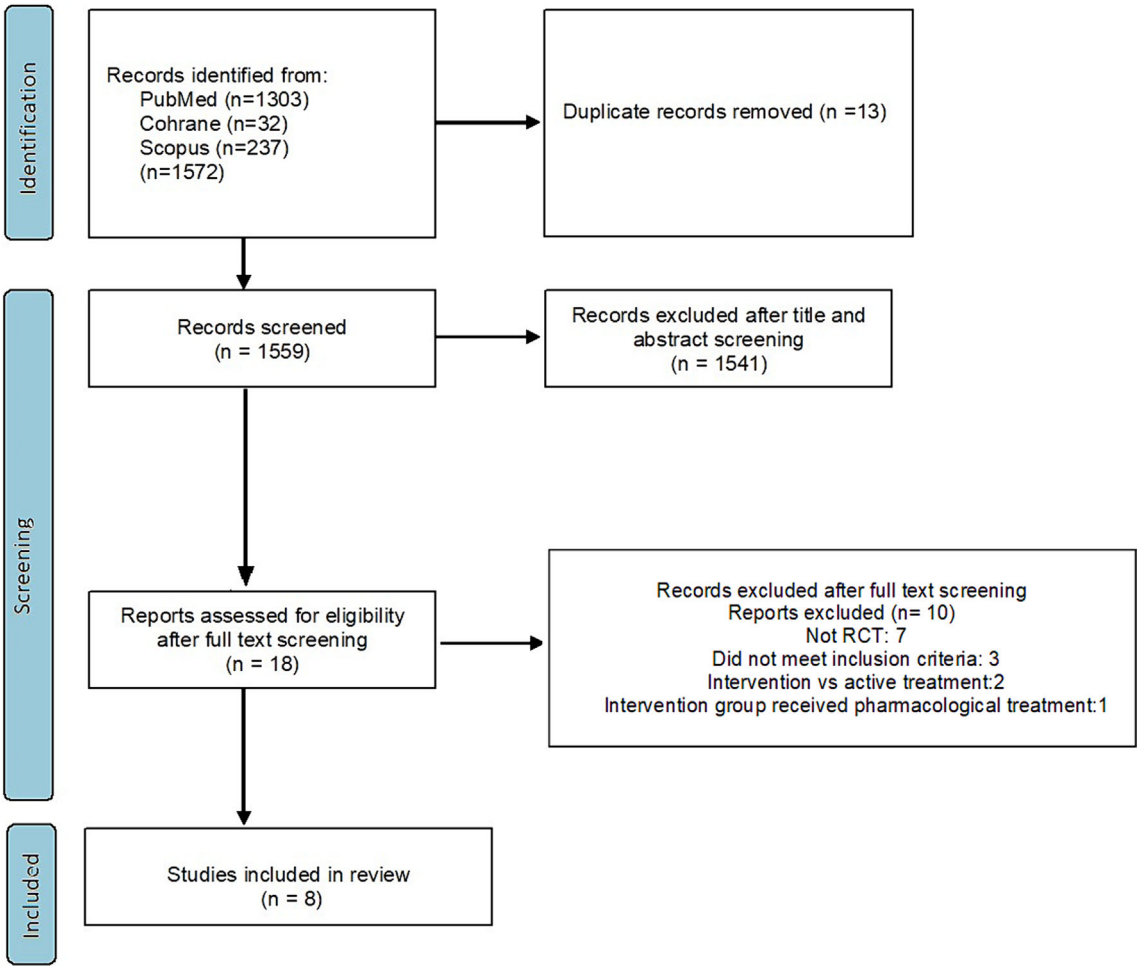

FIGURE 1 PRISMA flow chart for the study selection process.

children with CP, we estimated the weighed mean differences and 95% confidence intervals (CIs). For weighted mean differences, a point estimate of zero reflected 'no effect', and more than zero favoured the intervention. Statistical heterogeneity was assessed by using the χ^2 (chi-squared) test ($P < 0.1$). Chi-squared test assesses whether observed differences in results are compatible with chance alone. A low *P* value provides evidence of heterogeneity of intervention effects (https://training.cochrane.org/handbook/current/chapter-10, n.d.) The I^2 statistic was also calculated. The I^2 statistic describes the percentage of variation across studies that is due to heterogeneity rather than chance (Higgins & Thompson, 2002). We considered $I^2 > 50\%$ to indicate significant heterogeneity across studies (Higgins et al., 2003). Random effects method for meta-analysis was used because it allows the outcomes to vary in a normal distribution between studies. Only if I^2 is low a fixed effect model might be used, assuming that all studies were conducted under similar conditions with similar subjects (Ades et al., 2005).

Since three studies used more than one measurement tools to assess participation, we only considered the primary outcome in our meta-analysis. When subscale scores were reported, only one of the scores was included, the most common used by most RCTs.

3 | RESULTS

3.1 | Characteristics of included trials

Eight RCTs were included in this systematic review (Figure 1). Descriptive characteristics and results of all included studies are presented in Table 1. Six studies (Armstrong et al., 2020; Clutterbuck et al., 2022; Gibson et al., 2018; Reedman et al., 2019; Ryan et al., 2020; Scholtes et al., 2012) were short term, with an 8–12-week follow-up, one study (Van Wely et al., 2014) had follow-ups at 6 and 12 months, and one study (Verschuren et al., 2007) had follow-ups at 4, 8 and 12 months. In all studies, the control group received usual care, which incorporated regular pediatric physiotherapy, occupational therapy and speech therapy in the community. PEDro scores are detailed in Table 2.

3.2 | Characteristics of participants

In this systematic review, 384 children were included (195 intervention group, 189 control group), mean age ranged from 6 to 19 years

TABLE 1 Characteristics of the included studies.

Author(s) year	Sample size IG/CG	Age range–mean (years: months)	Sex (F%)	GMFCS (I, II, III, IV)	CP	Evaluation time point	Intervention	Control	Outcome measure_ participation	Outcome measure_other	Result
Armstrong et al. (2020)	11/10	6–18 10:4	62	0/6/6/9	Spastic 90%	8 weeks	30 min of FES cycling and 30 min of goal-directed training (3/week)	UC	PEMCY COPM	GMFM-88 GMFM-66	Improvement in gross motor function, goal performance and satisfaction (COPM) No between groups difference in participation (PEMCY)
Gibson et al. (2018)	21/21	9–18 12:5	38.1	24/17/1/0	Spastic 100% 1 dystonia	12 weeks	Two 1-h sessions per week running training intervention	UC	PEMCY	GAS HiMAT SRT	Increased achievement of running-related goals Increased frequency of participation at school (within group analysis)
Reedman et al. (2019)	18/19	8–12 9:8	55.6	21/9/7/0	Spastic 92%	8 weeks	8 × 60 min sessions in 8 weeks' goal setting and scoring, enabling the child's ongoing participation	WL UC	PEMCY COPM	BiGSS HPA BPPA-Q	Greater perceived goal performance and satisfaction (COPM) No difference in HPA No between groups difference in participation (PEMCY)
Ryan et al. (2020)	33/31	10–19 13:11	45	29/25/10/0	Spastic 100%	10 weeks	30 sessions of resistance training of the ankle plantar-flexors over 10 weeks	UC	Life-H score	GMFM-66 NNcost	No improvement in gait efficiency, muscle strength, activity, participation or any biomechanical outcome
Scholtes et al. (2012)	26/25	6–13 10:4	44	NA	Spastic 100%	12 weeks	12 weeks functional PRE circuit training, for 3 times a week	UC	CAPE	10MWT 1MFWT TST	Improvement in muscle strength No improvement in walking ability-participation
Van Wely et al. (2014)	25/24	7–13 9:5	52	28/12/9/0	Spastic 100%	6 months 12 months	Physical activity stimulation programme (6 months) Fitness training programme (4 months)	UC	Life-H score CAPE	Harter's Self-Perception Profile for Children Cerebral Palsy Quality of Life questionnaire	Positive effect on participation in domestic life in 12 months, not in 6 months No other improvement
Verschuren et al. (2007)	34/34	7–18	35.3	47/21/0/0	Spastic 100%	4 months 8 months 12 months	45 min of aerobic and anaerobic training, twice per week (8 months)	UC	CAPE	10-m shuttle run test Muscle Power Sprint Test Self-	Improvements on aerobic and anaerobic capacity, agility, muscle strength and athletic competence

(Continues)

TABLE 1 (Continued)

Author(s) year	Sample size IG/CG	Age range–mean (years: months)	Sex (F%)	GMFCS (I, II, III, IV)	CP	Evaluation time point	Intervention	Control	Outcome measure_ participation	Outcome measure_other	Result
										Perception Profile for Children GMFM-88 TACQOL	The intensity of participation showed a positive effect for formal, overall, physical and skilled-based activities (8 months), not at the follow-up (12 months) On the health related quality of life measure, a Significant improvement was found for the motor, autonomy and cognition domains
Clutterbuck et al. (2022)	29/25	6–12	35	17/37/0/0	Spastic 87% Other 13%	8 weeks 20 weeks	1 h session per week of combined sports-specific gross motor activity training, sports education, teamwork development and confidence building for four sports: Soccer, netball, T-ball and cricket (8 weeks)	UC	mCOPM CAPE	TGMD-2 GMFM Challenge MPST CP QOL-Child	Significant improvements for sports participation No other improvement

Abbreviations: 1MFWT, 1-min fast walk test; BiGSS, Belief in Goal Self-competence Scale; BPPA-Q, Barriers to Participation in Physical Activities Questionnaire; CAPE, Children's Assessment of Participation and Enjoyment; CG, control group; COPM, Canadian Occupational Performance Measure; CP QOL-Child, Cerebral Palsy Quality of Life-Child; F, female; FES, Functional Electrical Stimulation; GAS, Goal Attainment Scaling; GMFCS, Gross Motor Function Classification System; GMFM, Gross Motor Function Measure; HiMAT, High Level Mobility Assessment Tool; HPA, habitual physical activity; IG, intervention group; Life-H score, Assessment of Life Habits Questionnaire; MPST, Muscle Power Sprint Test; NNcost, non-dimensional oxygen cost; PRE, Progressive Resistance Exercise; 10MWT, 10-m walk test; SRT, 10-m shuttle run test; TACQOL, TNO-AZL Questionnaire for Children's Health-Related Quality of Life; TGMD-2, Test of Gross Motor Development, Second Edition; TST, Timed Stair Test; UC, usual care; w, week; WL, waiting list.

TABLE 2 Risk of bias of the included studies, based on the PEDro tool.

Author	Randomized allocation	Concealed allocation	Comparable at baseline	Blinded subjects	Blinded therapist	Blinded assessors	Adequate follow-up	Intention-to-treat analysis	Group comparisons	Point-estimated and variability	Total score
Armstrong et al. (2020)	−	+	−	−	+	+	+	+	+	+	7_10
Gibson et al. (2018)	−	+	−	−	+	+	−	+	+	+	6_10
Reedman et al. (2019)	+	+	−	−	−	+	+	+	+	+	7_10
Ryan et al. (2020)	+	+	−	−	+	+	+	+	+	+	8_10
Scholtes et al. (2012)	+	+	−	−	+	+	+	+	+	+	8_10
Van Wely et al. (2014)	+	+	−	−	−	+	+	+	+	+	7_10
Verschuren et al. (2007)	+	+	+	−	−	+	+	+	+	+	8_10
Clutterbuck et al. (2022)	+	+	+	−	−	+	−	−	+	+	6_10

Note: PEDro scores of 0–3 are considered *poor*, 4–5 *fair*, 6–8 *good* and 9–10 *excellent*; a total PEDro score of 8/10 is optimal.
Source: Cashin and McAuley (2020).

old. Out of a total of 384 participants (224 males and 160 females, accounting for 58% males), four studies had almost equally represented sexes (Reedman et al., 2019; Ryan et al., 2020; Scholtes et al., 2012; Van Wely et al., 2014), while one study (Armstrong et al., 2020) had more females and another three studies (Clutterbuck et al., 2022; Gibson et al., 2018; Verschuren et al., 2007) more male participants. All studies recruited almost exclusively children with spastic type of CP and in some studies (Clutterbuck et al., 2022; Gibson et al., 2018; Reedman et al., 2019), other types of CP (i.e. dystonia) were additionally included. Most studies (Gibson et al., 2018; Reedman et al., 2019;Ryan et al., 2020; Van Wely et al., 2014) recruited children with GMFCS levels I–III, one study (Armstrong et al., 2020) included children with GMFCS levels II–IV, two studies included children with GMFCS levels I and II (Clutterbuck et al., 2022; Verschuren et al., 2007), and one study (Scholtes et al., 2012) did not specify.

3.3 | Characteristics of interventions

A variety of therapeutic interventions was identified. Four studies (Ryan et al., 2020;Scholtes et al., 2012; Van Wely et al., 2014; Verschuren et al., 2007) applied interventions that target body function and structure, two studies (Armstrong et al., 2020; Gibson et al., 2018) targeted activity, while another two studies (Clutterbuck et al., 2022; Reedman et al., 2019) used participation-focused interventions. The detailed description of each included study and corresponding interventions is available in Table S2.

3.4 | Characteristics of outcome measures

The included outcome measures also varied. Regarding participation, four measures were used: PEM-CY ($n = 3$) (Armstrong et al., 2020; Gibson et al., 2018; Reedman et al., 2019), Life-H ($n = 2$) (Ryan et al., 2020; Van Wely et al., 2014), CAPE ($n = 3$) (Scholtes et al., 2012; Van Wely et al., 2014; Verschuren et al., 2007) and Canadian Occupational Performance Measure (COPM) ($n = 3$) (Armstrong et al., 2020; Clutterbuck et al., 2022; Reedman et al., 2019). Three studies used more than one outcome measures for participation, that is, PEM-CY together with COPM (Armstrong et al., 2020; Reedman et al., 2019) and Life-H with CAPE (Van Wely et al., 2014). In alignment with fPRCs, only PEM-CY and CAPE measure attendance and involvement (Resch et al., 2020). In all studies, participation outcome measures were primary, with the exception of the study by Ryan et al.'s study where it was a secondary outcome measure (Ryan et al., 2020). When two participation outcome measures were used, COPM was the primary and PEM-CY the secondary outcome (Armstrong et al., 2020; Reedman et al., 2019), with the exception of Van Wely et al. (2014) where this was not specified. All studies additionally assessed other primary or secondary outcomes, mostly related to motor function. Detailed description of the outcome measures used in each study is presented in the Supporting Information.

3.5 | Meta-analysis and the effect on participation based on intervention and outcome measures

Overall, there was an improvement in participation for the intervention groups compared to control groups at any environment, that is, school, home, community, regardless of the intervention frequency, intensity, diversity, enjoyment, involvement or the type of intervention, that is, recreational, active physical, social, skill-based and self-improvement. Eight studies were included in the meta-analysis. The forest plot describing data synthesis of the studies showed a standardized mean difference (95% CI) of 0.76 (0.1–1.42); $Z = 2.27$; $P = 0.02$, with very high heterogeneity $Chi^2 = 62.62$, $I^2 = 89\%$ (Figure 2). Although in a first glance it appears that interventions favour participation, when looking closer, it becomes obvious that only three studies actually produce this effect: Armstrong's, Clutterbuck's and Reedman's. Given the high heterogeneity of the results, we run a sensitivity analysis focused on the intervention applied.

In this review, included interventions targeted different ICF domains, that is, Body Functions and Structures, Activities and Participation. Regarding the sensitivity analysis of the different interventions, four studies targeted Body Function and Structure (Ryan et al., 2020; Scholtes et al., 2012; Van Wely et al., 2014; Verschuren et al., 2007). The sensitivity analysis showed that interventions

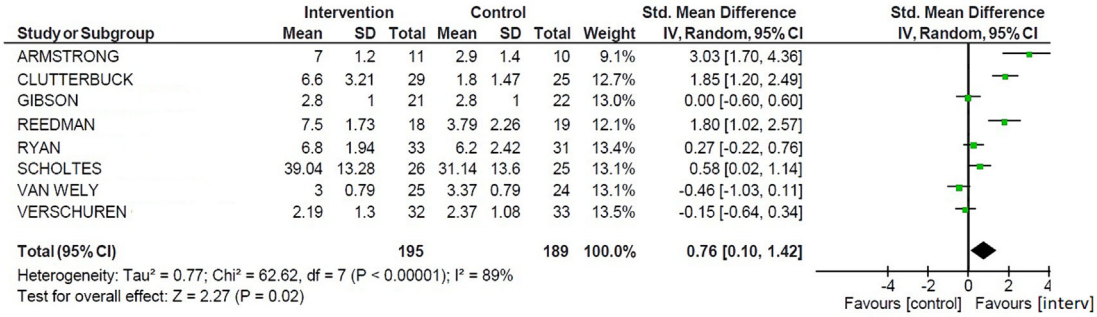

FIGURE 2 Forest plot of the effect of all types of interventions on Participation. Author name and outcome measure used: Armstrong_COPM, Clutterbuck_COPM, Gibson_PEMCY, Reedman_COPM, Ryan_LIFE H, Scholtes_CAPE, Van Wely_ CAPE, Verschuren_CAPE.

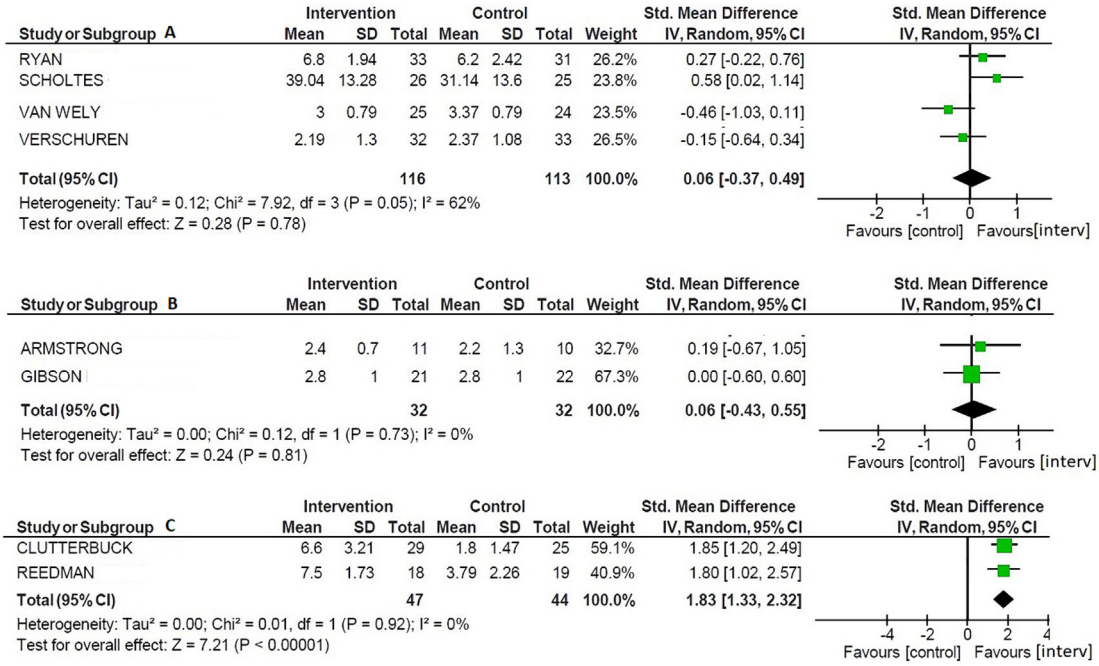

FIGURE 3 Forest plot of the effect on Participation: sensitivity analysis focusing on interventions; subgroup. (a) Interventions targeting Body Functions, subgroup. Author name and outcome measure used: Ryan_LIFE H, Scholtes_CAPE, Van Wely_ CAPE, Verschuren_CAPE. (b) Interventions targeting Activities, subgroup. Author name and outcome measure used: Armstrong_COPM, Gibson_PEMCY. C: interventions targeting Participation. Author name and outcome measure used: Clutterbuck_COPM, Reedman_COPM.

targeting Body Functions did not favour the intervention group; standardized mean difference (95% CI) 0.06 (−0.37–0.49); Z = 0.28; $P = 0.78$, $Chi^2 = 7.92$, $I^2 = 62\%$ (Figure 3a). Two studies targeted Activities (Armstrong et al., 2020; Gibson et al., 2018), but again, sensitivity analysis did not reach significance level; standardized mean difference (95% CI) 0.06 (−0.43–0.55); Z = 0.24; $P = 0.81$, $Chi^2 = 0.12$, $I^2 = 0\%$ (Figure 3b). Finally, sensitivity analysis of two studies that targeted Participation (Clutterbuck et al., 2022; Reedman et al., 2019) significantly favoured the intervention group; standardized mean difference (95% CI) 1.83 (1.33–2.32); Z = 7.21; $P < 0.00001$, $Chi^2 = 0.01$, $I^2 = 0\%$ (Figure 3).

4 | DISCUSSION

This systematic review and meta-analysis identified the effects of therapeutic interventions on participation among children with CP using eight RCTs with a total number of 384 patients. Overall, the therapeutic interventions improved participation. However, during the sensitivity analysis, it became evident that interventions targeting participation directly had a notable influence on participation, whereas those focusing on body functions, structures or activities did not yield significant effects on participation.

In our review, all but two of the included studies used conventional interventions that focus on improving mobility, such as cycling, running training, resistance training, progressive resistance exercise, physical activity and fitness training programme (Clutterbuck et al., 2022; Reedman et al., 2019). Reedman et al. (2019) used a participation-focused therapy targeting both activity limitations and barriers to participation, and Clutterbuck et al. (2022) utilized an intervention programme that targets specific gross motor activity training, aspects of the environment (sport education, teamwork development) and personal factors (confidence building) for specific sports. These studies demonstrated statistically significant improvement in participation, which supports the enablement theory, that is, that the interventions that are tailored to influence participation rather than improve muscle strength or muscle tone can indeed improve participation. At the same time, children that significantly improved certain skills at the level of body functions and structures and/or activities after intervention did not necessarily improved their participation.

According to the treatment theory (Whyte et al., 2014), the therapeutic goal should be the most proximal to the treatment target clinical characteristic that, if changed, a functional significance is indicated. This is probably the most efficient way to produce change in a treatment target and support functional improvement. However, in rehabilitation, the clinically significant aim is often remote from the treatment target as defined by the treatment theory. It is usual practice to target a body structure or a functional deficit (i.e. impairment) when our final target is to improve an activity or an aspect of participation that is influenced by the impairment. Still, in the case of participation, the effectiveness of the intervention depends on several other limitations in the physical and social environment of the child that influence the different dimensions of participation, that is, attendance, involvement, engagement, motivation, social connection and preferences (Imms et al., 2017). These aspects are highly unlikely to be influenced by interventions that target specific structures or

impairments. On the other hand, understanding the relation among clinical characteristics in order to predict if interventions can affect the different dimensions of participation may be more efficient in improving participation (Whyte, 2014).

Although previous systematic reviews also show that targeting body structure and function is not an effective way to promote participation, rehabilitation culture is still largely driven by the biomedical model towards healing, that is, fixing a structure or improving a function (Wright et al., 2008). This is supported by an assumption that performing an activity better or more skilfully will promote participation to that specific activity. However, the question that arises is how much the beneficiary, who is the child with CP, actually benefited from this kind of intervention in real life. It is likely that these individual achievements cannot guarantee the successful participation of a child with CP in life situations, and this aspect of life was rarely assessed (Wright et al., 2008). In addition, affecting one specific body function or structure, that is, strengthening a muscle, is easier to perform and monitor within a standard rehabilitation setting. Changing several parameters in different settings requires intervention in many different people and contexts. Thus, it is of great interest to consider whether improving participation should be a completely different approach, provided in a different setting by a group of experts that target exclusively participation.

Following the ICF definition, the introduction of the ICF-CY and particularly after the development of the fPRCs, participation is addressed more globally. Development of appropriate tools to measure participation was followed. However, low or high participation also depends on how much the individual feels comfortable participating, in specific activities, and how often. In addition, involvement, although is apparently considered as one of the most important dimensions of participation, it describes an internal state, that is, the experience of the person while attending (Imms et al., 2017). This leads into challenges on observing and recording involvement, as this does not require observable execution of an activity per se. Therefore, participation is perceived differently by different persons, and a tool cannot easily consolidate all its perceptions, given that it encompasses various dimensions of the underlying construct being measured.

In our systematic review, the studies that used COPM as an outcome measure documented improvement in participation, compared to controls. Two studies (Armstrong et al., 2020; Reedman et al., 2019) that used COPM and PEM-CY as their outcomes did not have similar results. Reedman et al. (2019) suggested that this can be explained by the purpose of using PEM-CY. Specifically, PEM-CY assesses also participation in activities that do not include physical activities, and since the intervention in the study targeted physical activities, it can be expected that this tool cannot record relevant improvement. On the contrary, COPM asks the child to select the activities of interest and report change in participation. Thus, measurement tools that assess participation in more activities and in different environments may have issues in detecting changes in participation if this change happens in a few activities of choice.

The COPM is an individualized measure that identifies the five more urgent problems and rates them according to the ability to perform and the satisfaction with that performance. Although COPM does not clearly refers to the concepts of attendance or involvement, it practically allows the child to choose the activity of interest thus increasing the probability of selecting a preferred activity in a specific context in which the child eventually wishes to be involved. On the other hand, COPM's structure and format cannot guarantee that the selected goals target solely participation and not the activity, unless the goals are extensively described for each child. Hence, we have to be cautious in the interpretation of our results regarding whether we exclusively address and measure participation.

One of the main findings of this work is that participation did not improve with any type of therapeutic intervention but only when intervention was specifically focused on it. Previous systematic reviews that have investigated the effect of any type of intervention on participation in children with any type of disability have similar results (Adair et al., 2015; Bania et al., 2019; Reedman, Boyd, & Sakzewski, 2017). There are several reasons for this. Studies included in this meta-analysis were only RCTs, as they are the most reliable design to assess the effectiveness of an intervention. Still, in the case of participation and a parallel RCT design, it is almost impossible to allocate children equally in control and experimental groups, since personal characteristic such as willingness, motivation, special interests and temperament of each child cannot be assessed and measured. Thus, there is an assumption that both groups included children that shared common personality traits. In addition, it is likely that RCTs cannot account for the context of an activity, which is a critical element that influences involvement and consequently participation. A cross-over RCT design, where the same group of children are assessed before and after the interventions, could be more appropriate to assess participation. In support of this, Gibson et al.'s (2018) study showed that although there were no differences between groups, there was a statistically significant difference when the assessment was made within the intervention group.

Another important issue could be the duration of the intervention. Most of the included studies were short term with duration from 8 to 12 weeks. Only Van Wely et al. (2014) and Verschuren et al. (2007) applied intervention programmes for longer periods, that is, 6 and 8 months, respectively. Interestingly, Verschuren et al. reported a significant improvement in participation at 8 months that did not last beyond their second follow-up at 12 months. This finding may indicate that longer periods of fitness exercising may be beneficial for the time they are applied as they increase attendance and frequency of participation in specific activities, but long-time participation in different contexts requires more permanent changes that allow the children to be involved in activities no matter how fit they are.

4.1 | Strengths and limitations

This systematic review included RCTs that presented a low risk of bias, and only studies that included scales specifically designed to measure participation were considered. Regarding the timing of assessment, our meta-analysis used a follow-up of 8 weeks, because

this was the most commonly referred follow-up time. Still longer studies for the intervention are needed. With regard to the limitations of this work, the number of studies and the sample sizes were small. Although the lack of blinding of both subjects and investigators is inevitable in many cases, blinding could have been applied in the analysis stage. Finally, there was also a variety of interventions and outcome measures used in a non-homogeneous patient group of children, regarding the CP severity. Future studies should have a well-described patient group with similarities if possible or use a cross-over design.

5 | CONCLUSION

Participation is integral to the daily lives of children. After the implementation of ICF, studies have started to investigate the effect of various interventions on participation. This systematic review and meta-analysis show that interventions that are designed to primarily improve the child's motor function do not necessarily improve participation. Conversely, interventions that primarily address barriers to participation across several ICF domains have a more substantial impact on enhancing participation.

In addition, RCTs may not be the most suitable study designs to measure changes in participation as they fail to incorporate children's personal factors, such as willingness, motivation, special interests, temperament and the environment or the context that have an effect on participation. Finally, appropriate outcome measures that take into account the child's preferences and choices, such as COPM, are likely more adept at comprehensively capturing participation. To fully understand the participation restrictions of children with CP and explore ways to overcome them, more studies are needed, focusing mainly on participation and with carefully selected and responsive outcome measures.

AUTHOR CONTRIBUTIONS

Rigas Dimakopoulos: Conceptualization; investigation; methodology; writing - original draft; writing - review and editing. **Theodora Vakalaki:** Investigation. **Arietta Spinou:** Writing - review and editing; methodology. **Ioannis Michopoulos:** Methodology; validation; software. **Marianna Papadopoulou:** Methodology; validation; supervision; writing - review and editing; writing - original draft.

CONFLICT OF INTEREST STATEMENT

None of the authors have conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in polynoe at https://polynoe.lib.uniwa.gr/xmlui/.

REFERENCES

Adair, B., Ullenhag, A., Keen, D., Granlund, M., & Imms, C. (2015). The effect of interventions aimed at improving participation outcomes for children with disabilities: A systematic review. *Developmental Medicine and Child Neurology*, *57*, 1093–1104. https://doi.org/10.1111/dmcn.12809

Ades, A. E., Lu, G., & Higgins, J. P. T. (2005). The interpretation of random-effects meta-analysis in decision models. *Medical Decision Making*, *25*, 646–654. https://doi.org/10.1177/0272989X05282643

Anaby, D., Hand, C., Bradley, L., DiRezze, B., Forhan, M., DiGiacomo, A., & Law, M. (2013). The effect of the environment on participation of children and youth with disabilities: A scoping review. *Disability and Rehabilitation*, *35*, 1589–1598. https://doi.org/10.3109/09638288.2012.748840

Anaby, D. R., Law, M., Feldman, D., Majnemer, A., & Avery, L. (2018). The effectiveness of the pathways and resources for engagement and participation (PREP) intervention: Improving participation of adolescents with physical disabilities. *Developmental Medicine and Child Neurology*, *60*, 513–519. https://doi.org/10.1111/dmcn.13682

Armijo-Olivo, S., da Costa, B. R., Cummings, G. G., Ha, C., Fuentes, J., Saltaji, H., & Egger, M. (2015). PEDro or Cochrane to assess the quality of clinical trials? A meta-epidemiological study. *PLoS ONE*, *10*, e0132634. https://doi.org/10.1371/journal.pone.0132634

Armstrong, E. L., Boyd, R. N., Horan, S. A., Kentish, M. J., Ware, R. S., & Carty, C. P. (2020). Functional electrical stimulation cycling, goal-directed training, and adapted cycling for children with cerebral palsy: A randomized controlled trial. *Developmental Medicine and Child Neurology*, *62*, 1406–1413. https://doi.org/10.1111/dmcn.14648

Bania, T., Chiu, H.-C., & Billis, E. (2019). Activity training on the ground in children with cerebral palsy: Systematic review and meta-analysis. *Physiotherapy Theory and Practice*, *35*, 810–821. https://doi.org/10.1080/09593985.2018.1460647

Batorowicz, B., King, G., Mishra, L., & Missiuna, C. (2016). An integrated model of social environment and social context for pediatric rehabilitation. *Disability and Rehabilitation*, *38*, 1204–1215. https://doi.org/10.3109/09638288.2015.1076070

Bedell, G., Coster, W., Law, M., Liljenquist, K., Kao, Y. C., Teplicky, R., Anaby, D., & Khetani, M. A. (2013). Community participation, supports, and barriers of school-age children with and without disabilities. *Archives of Physical Medicine and Rehabilitation*, *94*, 315–323. https://doi.org/10.1016/j.apmr.2012.09.024

Cashin, A. G., & McAuley, J. H. (2020). Clinimetrics: Physiotherapy evidence database (PEDro) scale. *Journal of Physiotherapy*, *66*, 59. https://doi.org/10.1016/j.jphys.2019.08.005

Charrois, T. L. (2015). Systematic reviews: What do you need to know to get started? *The Canadian Journal of Hospital Pharmacy*, *68*, 144–148. https://doi.org/10.4212/cjhp.v68i2.1440

Clutterbuck, G. L., Auld, M. L., & Johnston, L. M. (2022). SPORTS STARS: A practitioner-led, peer-group sports intervention for ambulant children with cerebral palsy. Activity and participation outcomes of a randomised controlled trial. *Disability and Rehabilitation*, *44*, 948–956. https://doi.org/10.1080/09638288.2020.1783376

Gibson, N., Chappell, A., Blackmore, A. M., Morris, S., Williams, G., Bear, N., & Allison, G. (2018). The effect of a running intervention on running ability and participation in children with cerebral palsy: A randomized controlled trial. *Disability and Rehabilitation*, *40*, 3041–3049. https://doi.org/10.1080/09638288.2017.1367426

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, *21*, 1539–1558. https://doi.org/10.1002/sim.1186

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *Bmj*, *327*, 557–560. https://doi.org/10.1136/bmj.327.7414.557

Chapter 10: Analysing data and undertaking meta-analyses. https://training.cochrane.org/handbook/current/chapter-10 (accessed 5 April 2024).

Imms, C., Granlund, M., Wilson, P. H., Steenbergen, B., Rosenbaum, P. L., & Gordon, A. M. (2017). Participation, both a means and an end: A conceptual analysis of processes and outcomes in childhood disability.

Developmental Medicine and Child Neurology, *59*, 16–25. https://doi.org/10.1111/dmcn.13237

Kilgour, G., Adair, B., Stott, N. S., Steele, M., Hogan, A., & Imms, C. (2022). Do physical activity interventions influence subsequent attendance and involvement in physical activities for children with cerebral palsy: A systematic review. *Disability and Rehabilitation*, *44*, 1682–1698. https://doi.org/10.1080/09638288.2021.1909151

Law, M., Petrenchik, T., King, G., & Hurley, P. (2007). Perceived environmental barriers to recreational, community, and school participation for children and youth with physical disabilities. *Archives of Physical Medicine and Rehabilitation*, *88*, 1636–1642. https://doi.org/10.1016/j.apmr.2007.07.035

McIntyre, S., Goldsmith, S., Webb, A., Ehlinger, V., Hollung, S. J., McConnell, K., Arnaud, C., Smithers-Sheedy, H., Oskoui, M., Khandaker, G., Himmelmann, K., & The Global CP Prevalence Group*. (2022). Global prevalence of cerebral palsy: A systematic analysis. *Developmental Medicine and Child Neurology*, *64*, 1494–1506. https://doi.org/10.1111/dmcn.15346

Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan—A web and mobile app for systematic reviews. *Systematic Reviews*, *5*, 210. https://doi.org/10.1186/s13643-016-0384-4

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Bmj*, *372*, n71. https://doi.org/10.1136/bmj.n71

Reddihough, D. (2011). Cerebral palsy in childhood. *Australian Family Physician*, *40*, 192–196.

Reedman, S., Boyd, R. N., & Sakzewski, L. (2017). The efficacy of interventions to increase physical activity participation of children with cerebral palsy: A systematic review and meta-analysis. *Developmental Medicine and Child Neurology*, *59*, 1011–1018. https://doi.org/10.1111/dmcn.13413

Reedman, S. E., Boyd, R. N., Elliott, C., & Sakzewski, L. (2017). ParticiPAte CP: A protocol of a randomised waitlist controlled trial of a motivational and behaviour change therapy intervention to increase physical activity through meaningful participation in children with cerebral palsy. *BMJ Open*, *7*, e015918. https://doi.org/10.1136/bmjopen-2017-015918

Reedman, S. E., Boyd, R. N., Trost, S. G., Elliott, C., & Sakzewski, L. (2019). Efficacy of participation-focused therapy on performance of physical activity participation goals and habitual physical activity in children with cerebral palsy: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*, *100*, 676–686. https://doi.org/10.1016/j.apmr.2018.11.012

Resch, C., Van Kruijsbergen, M., Ketelaar, M., Hurks, P., Adair, B., Imms, C., De Kloet, A., Piskur, B., & Van Heugten, C. (2020). Assessing participation of children with acquired brain injury and cerebral palsy: A systematic review of measurement properties. *Developmental Medicine and Child Neurology*, *62*, 434–444. https://doi.org/10.1111/dmcn.14465

RevMan. https://training.cochrane.org/online-learning/core-software/revman (accessed 8 Jan 2023).

Ryan, J. M., Lavelle, G., Theis, N., Noorkoiv, M., Kilbride, C., Korff, T., Baltzopoulos, V., Shortland, A., Levin, W., & The Star Trial Team. (2020). Progressive resistance training for adolescents with cerebral palsy: The STAR randomized controlled trial. *Developmental Medicine and Child Neurology*, *62*, 1283–1293. https://doi.org/10.1111/dmcn.14601

Sanger, T. (2015). Movement disorders in cerebral palsy. *Journal of Pediatric Neurology*, *13*, 198–207. https://doi.org/10.1055/s-0035-1558866

Scholtes, V. A., Becher, J. G., Janssen-Potten, Y. J., Dekkers, H., Smallenbroek, L., & Dallmeijer, A. J. (2012). Effectiveness of functional progressive resistance exercise training on walking ability in children with cerebral palsy: A randomized controlled trial. *Research in Developmental Disabilities*, *33*, 181–188. https://doi.org/10.1016/j.ridd.2011.08.026

Van Wely, L., Balemans, A. C., Becher, J. G., & Dallmeijer, A. J. (2014). The effectiveness of a physical activity stimulation programme for children with cerebral palsy on social participation, self-perception and quality of life: A randomized controlled trial. *Clinical Rehabilitation*, *28*, 972–982. https://doi.org/10.1177/0269215513500971

Verschuren, O., Ketelaar, M., Gorter, J. W., Helders, P. J. M., Uiterwaal, C. S. P. M., & Takken, T. (2007). Exercise training program in children and adolescents with cerebral palsy: A randomized controlled trial. *Archives of Pediatrics & Adolescent Medicine*, *161*, 1075–1081. https://doi.org/10.1001/archpedi.161.11.1075

Whyte, J. (2014). Contributions of treatment theory and enablement theory to rehabilitation research and practice. *Archives of Physical Medicine and Rehabilitation*, *95*, S17–23.e2. https://doi.org/10.1016/j.apmr.2013.02.029

Whyte, J., Dijkers, M. P., Hart, T., Zanca, J. M., Packel, A., Ferraro, M., & Tsaousides, T. (2014). Development of a theory-driven rehabilitation treatment taxonomy: Conceptual issues. *Archives of Physical Medicine and Rehabilitation*, *95*, S24–32.e2. https://doi.org/10.1016/j.apmr.2013.05.034

World Health Organization. (2001). *International classification of functioning, disability and health: ICF*. World Health Organization.

Wright, F. V., Rosenbaum, P. L., Goldsmith, C. H., Law, M., & Fehlings, D. L. (2008). How do changes in body functions and structures, activity, and participation relate in children with cerebral palsy? *Developmental Medicine and Child Neurology*, *50*, 283–289. https://doi.org/10.1111/j.1469-8749.2008.02037.x

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Dimakopoulos, R., Vakalaki, T., Spinou, A., Michopoulos, I., & Papadopoulou, M. (2024). Effectiveness of therapeutic interventions on participation in children with cerebral palsy: A systematic review and meta-analysis. *Child: Care, Health and Development*, *50*(4), e13301. https://doi.org/10.1111/cch.13301