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Comparative effects of social participation interventions for stroke survivors: A network meta-analysis using a social ecological model

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Abstract:	Abstract Background : Social participation is a core indicator of long-term recovery, but it significantly decreases after a stroke. Diverse single-, bi-, or multi-dimensional interventions showed differing effects on improving stroke survivors' participation. Objectives : To compare the effectiveness of current interventions based on the social ecological model in improving social participation among stroke survivors. Methods : Ten electronic databases were searched from their inception to April 2024, and additional searches were conducted in ProQuest, Google Scholar, and the reference lists of relevant reviews. Randomized controlled trials of interventions with the primary aim of improving social participation for stroke survivors aged 18 years and older were included. Pairwise meta-analysis and network meta-analysis were conducted. The intervention hierarchy was evaluated using the surface under the cumulative ranking curve (SUCRA) values. Results : A total of 32 articles with 3,211 participants were included, and 29 articles were eligible for meta-analysis. Pairwise meta-analysis indicated that different interventions were effective in improving social participation compared to control groups at post-intervention, but not at three, six, and 12 months after the intervention. The network meta-analysis showed that personal-physical environmental dimensional interventions were the most effective in improving social participation between baseline and post-intervention (SUCRA: 86%, SMD = 0.72, 95% CI = 0.20-1.25), followed by personal-interpersonal-physical environmental dimensional interventions (SUCRA: 85%, SMD = 0.75, 95% CI = 0.23-1.27) compared to control groups. Conclusions : Addressing personal and physical environmental barriers, or additionally incorporating interpersonal relationships improvement techniques, appears to be most effective in enhancing social participation among stroke survivors. Findings highlight the need for more rigorous multi-dimensional interventions to provide robust evidence. PROSPERPO Registration No.: CRD42024530157.

Cover Letter

Editorial Office

Annals of Physical and Rehabilitation Medicine

Dear Editor,

Re: Revised Manuscript Submission

Manuscript ID REHAB-D-25-00041R2

Title: Comparative effects of social participation interventions for stroke survivors: A network meta-analysis using a social ecological model

We would like to sincerely thank you and the reviewers for your constructive comments and suggestions on our manuscript. We have carefully revised the manuscript in accordance with the editor's and reviewers' feedback. All suggested changes have been incorporated, and detailed responses to each comment are provided in the accompanying response letter.

We believe that these revisions have significantly improved the clarity, accuracy, and overall quality of our work. We appreciate your time and effort in handling our submission, and we look forward to your further consideration of our revised manuscript for publication in *Annals of Physical and Rehabilitation Medicine*.

Thank you for your kind attention.

Sincerely,

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August 12, 2025

Revision 2

Response letter:

Dear Editors and Reviewers,

Thank you so much for giving us the opportunity to revise our manuscript again. We sincerely appreciate the constructive comments and suggestions provided on our manuscript entitled "*Comparative effects of social participation interventions for stroke survivors: A network meta-analysis using a social ecological model*" (Manuscript ID: REHAB-D-25-00041R2).

We have carefully considered all the feedback and revised the manuscript accordingly. Below, we provide a detailed, point-by-point response to each comment. The reviewers' comments are presented in the left column of the table, and our responses are shown in the right column, in red font. All changes in the revised manuscript are also marked in red font.

We hope the revised version of our manuscript meets your expectations and look forward to your positive consideration.

Sincerely,

All Authors.

Responses to Editors' and Reviewers' comments

Responses to Reviewer 3		
No.	**Suggestion**	**Responses**
1.	Transitivity Assessment: I appreciate the authors for adding the table that displays the distribution of effect modifiers across comparisons. However, presenting the values by individual study makes it difficult to get a clear overview. I suggest that the authors merge the data from all studies within the same treatment arm and report the values as a range (e.g., minimum-maximum). This would help readers to more easily assess whether effect modifiers overlap across treatment comparisons, which is a key component of evaluating transitivity.	Thank you for the insightful suggestion. In line with your comment, we now report the values of each effect modifier for treatment A (range) vs treatment B (range) to provide a clearer overview of the transitivity assumption. For example, in the comparisons between Per-Env and Control, the mean age was (54.75-64.8) vs (59.0-64.4). Please see the revised Appendix C, Table C3.
2.	Exclusion of Grey Literature: While I understand that the authors have excluded grey literature, I would like to raise concerns regarding the claim that the systematic review is less likely to have publication bias based on the funnel plot. Funnel plots primarily detect small-study effects,	Thank you very much for your insightful comment regarding the exclusion of grey literature and the assessment of publication bias. We fully agree that funnel plots have limitations and primarily detect small-study effects, which may not conclusively rule out publication bias. In our study, we excluded grey literature due to practical constraints

	which are used as a proxy and do not necessarily confirm or rule out publication bias. The inclusion of grey literature is one of the more effective ways to minimize such bias. I respectfully disagree with the notion that grey literature is necessarily of low quality. For example, dissertations are evaluated by academic committees, similar to peer-reviewed journal articles. If quality is a concern, the authors could consider conducting a sensitivity analysis excluding low-quality studies. However, if grey literature meets the inclusion criteria, it should be considered in the review to ensure comprehensive and unbiased evidence collection.	such as limited access, and concerns about data reproducibility. We acknowledge that this decision may limit the comprehensiveness of our review. We also appreciate your point that some forms of grey literature, such as dissertations, may undergo rigorous academic review. While we maintain our decision in this version, we will consider incorporating grey literature in future research when feasible. We have also added that excluding grey literature was one of the limitations of our study, "Additionally, searching multiple-language databases and including grey literature may enhance the comprehensiveness and reduce potential publication bias." Please see Page 21, lines 2-3.
3.	Use of Local Language Sources: I acknowledge the rationale provided for searching Chinese databases due to the cultural relevance of certain interventions. However, if culture-specific factors are expected to influence intervention effects, this could introduce heterogeneity in the outcomes. Therefore, it would be helpful for the authors to	Thank you very much for your valuable suggestion. We have changed the subgroup analysis by countries (e.g., Canada, the UK). In addition, we have also revised the corresponding illustration in the Discussion section. Methods: "Subgroup analyses were conducted based on age (65 years and older vs. less than 65 years), the country (i.e., Canada, China, the UK, Israel)..." (Page 9, line 29)

	explore this by conducting subgroup analyses by country, not region, to assess the potential modifying effect of study location.	The revised results found that interventions implemented in Israel had better effects than those in other countries, and we have also added this to the Discussion. "The relatively larger effect sizes (0.67) observed in interventions implemented in Israel may be related to cultural adaptation. For example, Harel-Katz et al. [62] conducted a culturally adapted, participation-focused self-management program for stroke survivors. The intervention provided information on local community resources and national policies, and the group discussions were also based on Israeli culture. By integrating culturally familiar content, the program may have improved participants' engagement and confidence in resuming social roles."

Highlights

- Social participation interventions show small effects in stroke survivors.
- Effects are not sustained at 3, 6, and 12 months post-intervention.
- Interventions in Israel, with individual format and ≥8 weeks, show greater effect.
- Personal-environmental interventions yield strongest effects on social participation.
- Clinics can implement interventions integrating personal and environmental resources.

Title

Comparative effects of social participation interventions for stroke survivors: a network meta-analysis using a social ecological model

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Title

Comparative effects of social participation interventions for stroke survivors: a network meta-analysis using a social ecological model

Abstract

***Background*:** Social participation is a core indicator of long-term recovery, but it significantly decreases after a stroke. Diverse single-, bi-, or multi-dimensional interventions showed differing effects on improving stroke survivors' participation.

***Objectives*:** To compare the effectiveness of current interventions based on the social ecological model in improving social participation among stroke survivors.

***Methods*:** Ten electronic databases were searched from their inception to April 2024, and additional searches were conducted in ProQuest, Google Scholar, and the reference lists of relevant reviews. Randomized controlled trials of interventions with the primary aim of improving social participation for stroke survivors aged 18 years and older were included. Pairwise meta-analysis and network meta-analysis were conducted. The intervention hierarchy was evaluated using the surface under the cumulative ranking curve (SUCRA) values.

***Results*:** A total of 32 articles with 3,211 participants were included, and 29 articles were eligible for meta-analysis. Pairwise meta-analysis indicated that different interventions were effective in improving social participation compared to control groups at post-intervention, but not at 3, 6, and 12 months after the intervention. The network meta-analysis showed that personal-physical environmental dimensional interventions were the most effective in improving social participation between baseline and post-intervention (SUCRA 86%, SMD 0.72, 95% CI 0.20-1.25), followed by personal-interpersonal-physical environmental dimensional interventions (SUCRA 85%, SMD 0.75, 95% CI 0.23-1.27) compared to control groups.

***Conclusions*:** Addressing personal and physical environmental barriers, or additionally

incorporating interpersonal relationships improvement techniques, appears to be most effective in enhancing social participation among stroke survivors. Findings highlight the need for more rigorous multi-dimensional interventions to provide robust evidence.

PROSPERPO Registration No.: CRD42024530157.

Keywords

Social Ecological Model; Stroke; Social Participation; Systematic Review; Network Meta-Analysis

Abbreviations

CINeMA: Confidence In Network Meta-Analysis

CNKI: China National Knowledge Infrastructure Library

COPM: Canadian Occupational Performance Measure

ICF: International Classification of Functioning, Disability and Health

IADL: Instrumental Activities of Daily Living

MeSH: Medical Subject Headings

Network Meta-analysis of Healthcare Interventions

Per-Env: personal-physical environmental dimensional intervention

Per-Int: personal-interpersonal dimensional intervention

PRISMA-NMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis -

RCTs: Randomized Controlled Trials

RoB: Risk of Bias

SF-36: Short-Form Health Survey 36 items

SinoMed: Chinese Biomedical Literature Database

SIS: Stroke Impact Scale

SUCRA: Surface Under the Cumulative Ranking Curve

VIP: Chinese Science and Technology Journal Database

Introduction

Stroke is a severe chronic disease with a high prevalence and recurrence rate. Stroke survivors face a higher risk of disability and mortality, leading to a significant management burden [1,2]. The long-term and wide-ranging effects of stroke on survivors include motor impairment [3], aphasia and dysarthria [4], depression [5], and cognitive impairment [6]. These multiple biological, psychological, and cognitive challenges significantly hinder stroke survivors' recovery and return to normal life. Stroke survivors also exhibit more sedentary behaviors and fatigue than healthy individuals [7,8].

Social participation is defined as "a person's involvement in life situations that provide interaction with others" [9,10]. Social participation can be classified into 4 domains: functional maintenance, interpersonal interactions, organizational participation, social services, and contributions [11]. Studies have demonstrated that higher levels of social participation are associated with better physical function [12,13], improved cognitive function [14], reduced depressive symptoms [13,15], and enhanced quality of life among stroke survivors [16]. Therefore, social participation is a key indicator of stroke recovery and a primary goal of long-term rehabilitation. Nevertheless, complex personal and environmental determinants may limit the improvement of social participation, such as physical impairments, psychological disorders, and environmental barriers [17,18], highlighting the importance of implementing comprehensive and personalized treatments.

The Canadian Stroke Best Practice Recommendations suggest providing physical/functional and psychological health management, telemedicine, stroke education and skills training, therapy targeting leisure, vocation, relationships, and sexuality, as well as support from family, peers, and the community to enhance social participation [19,20]. Several reviews and meta-analyses have summarized and pooled effects of interventions aimed at improving social participation through addressing personal-dimensional restrictions, including functional rehabilitation therapies (interventions that aim to promote function rehabilitation such as functional training, occupational therapy, physical therapy, speech therapy, and exercise) [21–24], self-management interventions [25,26], technology-based

therapies (interventions that use digital tools or technological platforms to deliver therapeutic support such as virtual reality therapies, and robot-assisted rehabilitation) [27,28], health education [24,29], and personal activity-focused interventions (eg, leisure activities and work) [30,31]. Zhou et al. [26] reviewed self-management interventions and found no significant effect on enhancing social participation among stroke survivors. Proffitt et al. [29] reviewed interventions aimed at improving social participation and reported low strength of evidence supporting the effectiveness of occupational therapy on social participation. Exercise-based interventions showed benefits for social participation [21,23]; however, these interventions addressed function-related barriers and failed to meet several specific needs related to social participation recovery, such as social interaction and organizational involvement. Given that social participation is influenced by multi-dimensional factors [17,18], single-dimensional interventions (eg, self-management) may be insufficient.

Several reviews have highlighted the effects of maintaining family and peer support environments [30,32], and addressing physical environmental barriers (eg, accessing transportation services skills) [31] on stroke survivors' social participation. Multi-dimensional interventions addressing personal and environmental barriers and providing effective resources might be better for enhancing social participation [21,24]. Current reviews evaluate the effects of a single type of intervention (eg, self-management) on social participation [23,26,32] or compare different interventions by analyzing the range of calculated effect sizes [30]. There is no consensus on which intervention is most effective in improving social participation or whether multi-dimensional interventions demonstrate better effects compared to the single-component ones.

The International Classification of Functioning, Disability and Health (ICF) framework considers both personal factors (ie, physical function) and environmental factors (ie, products and technology, attitude and services) to be associated with social participation [33]. However, the ICF emphasizes improving functional abilities and reducing environmental barriers to enhance social participation. The social ecological model is a theoretical framework that illustrates the origins of multi-dimensional determinants of health behaviors

(eg, social participation). Factors are categorized into personal, interpersonal, organizational, physical environmental, and cultural/political dimensions [34]. Many studies outline these multi-dimensional factors and support designing multi-dimensional interventions to enhance health-promoting behaviors, such as seeking psychiatric care [35,36], supporting community reintegration of stroke survivors [37]. Compared with the ICF framework, the social ecological model emphasizes broader social determinants, such as organizational and community factors. It also provides a valuable framework for developing dimension-specific strategies and integrating resources to enhance social participation more effectively. Therefore, the social ecological model can be used to classify multi-dimensional techniques for improving social participation and to help construct comprehensive and targeted interventions.

Network meta-analysis is an appropriate method for comparing the effects of different interventions through both direct evidence and indirect between-study comparisons. The analysis can also estimate relative rankings of interventions to inform recommendations [38]. Given the multifaceted nature of social participation and its determinants across multiple dimensions, there is an urgent need to synthesize the best available evidence on social participation interventions from a social ecological perspective. Such findings would be critical for mobilizing healthcare providers to design tailored programs that promote social reintegration and long-term recovery among stroke survivors.

Therefore, this systematic review and network meta-analysis aim to synthesize the social participation improvement interventions based on the social ecological model and compare the effectiveness of different dimensional strategies to improve social participation among stroke survivors.

Methods

Design

This study is a systematic review and network meta-analysis.

Regulatory and ethical aspects

Data were reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension statement for network meta-analysis of healthcare interventions (PRISMA-NMA) (See Appendix A) [39]. This review was prospectively registered in the PROSPERO International Prospective Register of Systematic Reviews (No. CRD42024530157).

Search methods

6 English electronic databases were searched: Web of Science, CINAHL, PubMed, Embase, Cochrane Central Register of Controlled Trials, and Scopus. Given the emphasis Chinese stroke survivors place on family and neighbor relationships [40], social participation interventions may reflect cultural specificity in China. Accordingly, 4 Chinese-language databases—WAN FANG Database, the China National Knowledge Infrastructure Library (CNKI), the Chinese Biomedical Literature Database (SinoMed), and the Chinese Science and Technology Journal Database (VIP)—were searched to identify additional local studies not indexed in international databases. All databases were searched from their inception to April 2024. Medical Subject Headings (MeSH) and keywords were combined using "OR" to enhance search strategies, including "Social participation" AND "Intervention" AND "Stroke" AND "Trials." Additional searches were also conducted in ProQuest Health & Medical Collection, Google Scholar, and the reference lists of relevant reviews and meta-analyses to reduce the risk of publication bias and to identify as much relevant evidence as possible. Detailed search strategies and results are provided in Appendix B.

Inclusion and exclusion criteria

Population

Eligible participants were adults aged ≥18 years, with a clinical diagnosis of stroke. Exclusions included participants with traumatic brain injury, transient ischemic attack, or

severe physical, psychological, or cognitive impairments (ie, severe motor dysfunction, depression, or advanced dementia).

Intervention

This systematic review included studies primarily aimed at improving social participation, such as those on occupational therapy, functional training, and self-management interventions. However, pharmacological interventions were excluded.

Comparison

The comparisons in the included studies could be wait-list control, usual care, health education, no interventions, or occupational therapy that differed from the intervention group. Studies were excluded if the intervention and control group used the same intervention with different techniques, such as technology-based therapies with different intervention durations.

Outcomes

Social participation was the primary outcome in the studies included in this review. In the context of this review, social participation refers to stroke survivors engaging in self-perceived meaningful and important activities in their daily life [9]. Objective indicators (eg, frequency, number of activities) or subjective perceptions (eg, satisfaction in participation) reported in studies were eligible for inclusion. Objective indicators were considered if the study reported both subjective and objective measures of social participation. Social participation can be measured using scales or self-designed questionnaires. Indicators collected through observation were excluded.

Study design

Randomized controlled trials (RCTs) were included in this review. Non-RCTs, such as quasi-experimental, case-control, or cohort studies, were excluded.

Publication type

Peer-reviewed articles with full text were included in this review. Conference abstracts, biographies, protocols, and dissertations were excluded.

Data selection

Two researchers (ZHJ and YYH) independently selected studies according to search strategies and imported the articles into EndNote (version X20). After duplicate articles were identified and excluded, the 2 researchers independently screened titles and abstracts to identify potentially eligible articles according to the inclusion and exclusion criteria, and then reviewed the full texts to select the final included articles. Any inconsistencies were discussed with a third researcher (LK).

Risk of bias

Version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB 2) was used to assess the quality of included studies [41]. The RoB 2 tool comprises 5 dimensions: bias in the randomization process, deviations from intended interventions, bias due to missing outcome data, bias in outcomes measurement, and bias in the selection of reported results. Each item and the overall judgment are rated as low (all domains rated as low risk), high risk (at least one dimension rated as high risk), or with some concerns (at least one dimension is rated as with some concerns and without high risk). Two researchers (ZHJ and YYH) independently used the RoB 2 tool to assess the risk of bias in the included RCTs. Disagreements were resolved through discussion with a third researcher (LK).

Data extraction

A pilot data extraction on 5 studies was conducted by 2 independent researchers (ZHJ and YYH), and the data extraction form was modified accordingly, including extracting measurements of social participation and reclassifying the intervention dimensions. Data on study characteristics, intervention details, types of control groups, baseline and follow-up

information on social participation were independently extracted by 2 researchers (ZHJ and YYH) using a modified data extraction form. Interventions were categorized into specific types according to the strategies they employed across the 5 dimensions of the social ecological model. Definitions and examples of techniques from different dimensional interventions were developed (Appendix C, Table C1). Among the 5 dimensions, a larger number of interventions were identified at the personal dimension, with considerable variation in type. To enhance comparison and identify best practice evidence, interventions within the personal dimension were further categorized (ie, functional rehabilitation therapy, leisure therapy). Therefore, a total of 11 categories of interventions were identified, such as functional rehabilitation therapy, technology-based therapy, leisure therapy, and personal-interpersonal dimensional intervention (Per-Int). Two researchers (ZHJ and YYH) independently classified the interventions according to the intervention techniques table. Discrepancies were resolved by cross-referencing original articles or consulting a third researcher (LK).

Statistical analyses

Stata Version 18.0 was used for both pairwise meta-analysis and network meta-analysis. First, the social participation outcome was a continuous variable; the change in means and standard deviations (SDs) between pre-intervention and post-intervention or follow-up periods was used to calculate the pooled effect size. Due to the different measurements used in the included studies for social participation, standardized mean differences (SMDs) with 95% confidence intervals (95% CIs) were calculated for the pooled effect size. Cohen's d was used to calculate SMDs, with values of 0.2-0.5 for small, 0.5-0.8 for medium, and >0.8 for large effect sizes[42]. Statistical heterogeneity among the included studies was evaluated using the Cochran's Q test and I^2 statistics, with statistical significance indicated by a Q test *P*-value <0.05 and I^2 >50%. A random effects model was applied to estimate the effect size from baseline to post-intervention (immediate effect), 3 months (short-term effect), 6 months (medium-term effect), and 12 months (long-term effect) after the intervention. Subgroup

analyses were conducted based on age (≥65 vs <65 years), the country (ie, Canada, China, the UK, Israel), intervention delivery modes (individual-based vs non-individual-based interventions), intervention duration (<8 vs ≥8 weeks), and the number of intervention dimensions (1, 2, 3, or 4). Sensitivity analysis was performed using the leave-one-out method to investigate the cause of statistical heterogeneity.

Second, a network meta-analysis, based on the frequentist method, was conducted. Network maps were used to describe direct or indirect comparisons between different interventions. Each node in the map represented an intervention, and the size of the node corresponded to the sample size for each intervention. The connecting lines between nodes indicated the direct comparisons of interventions, with the thickness of each line representing the number of directly compared interventions. If closed loops emerged in the network map, inconsistency was tested. The design-by-treatment interaction model was conducted for the global network inconsistency test [43]. Local network inconsistencies were estimated using node-splitting analysis [44]. A *P*-value <0.05 represented significant inconsistency between indirect and direct comparisons, in which case the inconsistency model was used; otherwise, the consistency model was applied. The SMD and 95% CI were calculated for the summary statistics. The surface under the cumulative ranking curve (SUCRA) was used to estimate ranking probabilities of intervention effects. The SUCRA score ranged from 0% to 100%, with a higher score representing a greater likelihood of being a better intervention. Publication bias was tested using comparison-adjusted funnel plots.

Assessment of transitivity

To ensure the comparability of social participation interventions regarding potential effect modifiers across the included studies, the transitivity assumption was evaluated to support the validity of indirect comparisons. The transitivity assumption can also be defined as participants being jointly randomized into any of the included interventions [45]. The distribution of effect modifiers, such as mean age, gender proportion, baseline stroke severity, and baseline levels of social participation, was systematically examined. For

unreported effect modifiers, transitivity was assessed by excluding the modifier from the evaluation.

Certainty assessment

The Confidence In Network Meta-Analysis (CINeMA) framework was used by 2 independent reviewers (ZHJ and YYH) to assess the confidence in the network meta-analysis results. 6 dimensions were assessed: within-study bias, reporting bias, indirectness, imprecision, heterogeneity, and incoherence [46]. For the evaluation of indirectness, we compared potential effect modifiers (eg, mean age) across studies to assess the similarity between the populations receiving different interventions. For imprecision, a minimal clinically important difference of 0.8 [47], ensuring that the results can be effectively applied to improve social participation for stroke survivors. The relative comparisons from the network meta-analysis were evaluated as “no concerns,” “some concerns,” or “major concerns.” The overall judgments of 6 dimensions were summarized into “high,” “moderate,” “low,” or “very low” judgments. If the judgment of the overall certainty of evidence was inconsistent, a discussion with a third researcher (LK) was conducted to reach a consensus.

Results

Search results

A total of 31,886 articles were identified in databases, along with 2,928 additional records from a gray literature search. After removing 5,620 duplicates, 29,194 articles remained for titles and abstracts. Of these, 1,571 full-text articles were assessed for eligibility, and finally, 32 articles were included in the review, with 29 articles included for the pairwise and network meta-analysis (Figure 1).

Risk of bias

The overview of the risk of bias for the 32 included studies and the evaluation for each

study are shown in Appendix C (Figures C1 and C2). In general, 44% (14/32) of the studies were assessed as having a low risk of bias. 50% (16/32) had unclear risks, primarily due to ambiguity in the randomization process, potential deviations from intended interventions, and bias from missing data. 6% (2/32) of the studies had a high risk of bias due to the incomplete description of the randomization process or significant differences between intervention and control groups at baseline, as well as bias from deviations from intended interventions.

Characteristics of included studies

The included 32 studies involved 3,211 participants, with sample sizes ranging from 15 to 568. The mean age (SDs) of participants was 66.41 (6.92), ranging from 51.7 to 78.9. Studies were published between 2002 and 2024 across 15 countries, including Canada (8/32, 25%) [48–55], the UK (5/32, 16%) [56–60], Israel (4/32, 13%) [61–64], and 11 other countries (15/32, 47%) [65–79] (Table 1, Appendix C, Table C2). 4 studies (13%) used a randomized crossover design [48,63,65,78], and 1 study was a 3-arm RCT [79].

The intervention delivery modes included face-to-face sessions (29/32, 91%) [49–66,68–72,74–79], virtual reality-based training (2/32, 6%) [67,73], and videoconferencing meetings (1/32, 3%) [48]. Most interventions were individual-based interventions (18/32, 56%) [48–50,53,55,56,58,61,63–65,67–69,71–73,75], followed by group-based interventions (either with participants together or with caregivers; 12/32, 38%) [51,52,54,59,60,62,66,70,74,77–79], and a combination of individual- and group-based interventions (2/32, 6%) [57,76]. The interventions were conducted at home (8/32, 25%) [48–50,53–55,74,79], rehabilitation centers (5/32, 16%) [58,62,64,66,67], community (2/32, 6%) [52,59], hospitals (2/32, 6%) [68,78], outpatient settings (1/32, 3%) [69], and day centers (1/32, 3%) [63]. 25% (8/32) of the studies performed interventions across multiple locations [51,56,65,70,72,75–77]. The intervention duration ranged from 2 weeks to 12 months, with 3 months being the most common duration (6/32, 19%) [52,62,63,71,77,79].

The intervention techniques for each dimension based on the social ecological model are shown in Table 2. For example, Chen et al. [65] developed an IADL (instrumental

activities of daily living) reablement intervention that incorporated both personal (ie, goal-directed IADL training) and physical environmental (ie, transportation training) dimension strategies. This intervention was classified as a personal-physical environmental dimensional intervention (Per-Env). All included interventions integrated personal-dimensional techniques. 46% (15/32) of interventions included interpersonal factors [50,51,54,56,59,60,62,63,66,70,76–79], 36% (12/32) organizational factors [49,51,52,54,57–60,62,76,78,79], 36% (12/32) physical environmental factors [48,51,53,58,61,63,65,66,69,70,72,77], and 9% (3/32) included cultural/political-dimensional factors [51,59,62]. 24% (8/32) were single-dimensional treatments [55,64,67,68,71,73–75] and 36% (12/32) were bi-dimensional treatments [48–50,52,53,56,57,61,65,69,72,79]. 27% (9/32) of the studies included 3-dimensional interventions [58,60,63,66,70,76–79], 9% (3/32) [54,59,62] included 4-dimensional interventions, and 3% (1/32) [51] included 5-dimensional interventions.

Control groups in the 32 included studies comprised usual care (15/32, 47%) [50,51,54–57,59–62,64,66,75,77,79], functional rehabilitation therapies (8/32, 25%) (including functional training, exercise, physical therapy, and occupational therapy) [53,67–69,72–74,76], wait-list control (4/32, 13%) [48,52,63,78], health education (3/32, 9%) [58,65,70], and no intervention (2/32, 6%) [49,71].

Social participation was measured using scales (30/32, 94%), activity counts (1/32, 3%) [55], or weekly leisure frequency (1/32, 3%) [75]. Scales used included the Short-Form health survey 36 items (SF-36) social function dimension (6/32, 19%) [54,58,71–73,76], Canadian Occupational Performance Measure (COPM) Performance (6/32, 19%) [48,53,61,63,65,69], Stroke Impact Scale (SIS) Participation dimension (5/32, 16%) [57,68,74,77,78], and 6 other scales (13/32, 41%) [49–52,56,59,60,62,64,66,67,70,79].

The follow-up duration ranged from 3 weeks to 15 months, with 3 months being the most common follow-up duration (12/32, 38%) [49,51,52,55–57,62,63,67,71,75,77]. A total of 19 studies (59%) measured social participation at baseline and post-intervention [48,51–55,60,62,63,65,66,69,71–76,79], while 13 studies (41%) employed multiple measurement

points [49,50,56–59,61,64,67,68,70,77,78].

Results of pairwise meta-analysis

Comparison between intervention and control groups at post-intervention

A total of 29 studies measuring social participation using various scales (eg, SIS, COPM) were included in the pairwise meta-analysis [48–50,52–58,60–78]. The results showed a significant treatment effect of social participation interventions at post-intervention (SMD 0.23, 95% CI 0.04-0.43, I^2 79%) compared with control groups. Subgroup analyses revealed that interventions implemented in the UK (SMD 0.24, 95% CI 0.12-0.36, I^2 0%) and Israel (SMD 0.67, 95% CI 0.00-1.34, I^2 80%) had a significantly small to moderate effect. Only individual-based interventions showed a significantly small effect (SMD 0.29, 95% CI 0.07-0.52, I^2 67%). Interventions lasting 8 weeks or longer showed a significantly small effect (SMD 0.30, 95% CI 0.06-0.55, I^2 82%). Three-dimensional interventions showed a significantly small effect on social participation compared to control groups (SMD 0.41, 95% CI 0.06-0.75, I^2 84%). Sensitivity analyses did not significantly change effect sizes when studies were removed one by one (Appendix C, Figures C3-C9).

Comparison between intervention and control groups at different follow-up times

Pairwise meta-analysis showed that social participation interventions did not significantly improve social participation compared to the control group at 3 months (SMD 0.38, 95% CI -0.24 to 0.99, I^2 = 74%) [57,61,67], 6 months (SMD 0.20, 95% CI -0.38 to 0.78, I^2 49%) [49,50,68], and 12 months (SMD 0.07, 95% CI -0.10 to 0.23, I^2 0%) after the intervention [49,58,70]. Subgroup analyses were not conducted due to insufficient studies. Sensitivity analyses did not reveal significant changes in effect size when excluding studies one by one (Appendix C, Figures C10-C15).

Results of network meta-analysis

Network plot

We combined usual care, wait-list control, health education, and no intervention into one control group. This approach could improve the precision of estimated effect sizes, enable indirect comparisons between treatments not directly compared in trials, and support more generalized conclusions [80–82]. A total of 12 interventions/control groups across 29 studies involving 2,501 participants were displayed in the network plot (Figure 2). Personal-interpersonal-physical environmental dimensional interventions and the control group were the most frequent comparisons (5/29, 17%), followed by technology-based therapies for functional rehabilitation (4/29, 14%). Among these interventions/control groups, the control groups had the largest sample size (1,025 participants), followed by functional rehabilitation therapies (229 participants), and technology-based therapies (110 participants).

Inconsistency test

The results of the inconsistency model indicated that there was no significant overall inconsistency among the included studies (P = 0.982), and the P-values from the node-splitting analysis were all >0.05. The results indicated no significant inconsistency between direct and indirect comparisons, supporting the validity of the network structure. Therefore, the consistency model was used to perform network meta-analysis.

Efficacy and ranking probability of interventions from baseline to post-intervention

Figure 3 shows the cumulative probability rankings of the effects of different interventions and control groups on social participation at post-intervention. The results revealed that personal-physical environmental dimensional interventions ranked highest in effectiveness (86%), followed by personal-interpersonal-physical environmental dimensional interventions (85%).

The relative effect of different interventions and control groups on social participation at post-intervention is shown in Table 3. The results demonstrated that, compared to control groups, personal-environmental dimensional interventions (SMD 0.72, 95% CI 0.20-1.25)

and personal-interpersonal-environmental dimensional interventions (SMD 0.75, 95% CI 0.23-1.27) showed significantly better treatment effects. Compared to personal-organizational dimensional interventions, personal-physical environmental dimensional interventions (SMD 1.23, 95% CI 0.50-1.97), personal-interpersonal-physical environmental dimensional interventions (SMD 1.26, 95% CI 0.52-1.99), leisure therapy (SMD 0.86, 95% CI 0.01-1.71) and functional rehabilitation therapies (SMD 0.75, 95% CI 0.03-1.48) exhibited significantly better effects on social participation. The results of all comparison-adjusted funnel plots suggested no potential publication bias for the network meta-analysis (Appendix C, Figure C16).

Transitivity assumption

There was no evidence of a violation of the transitivity assumption when comparing the selected modifiers, including mean age, gender proportion, time since stroke, baseline stroke severity, and baseline levels of social participation. No severe violation of the transitivity assumption was identified in this assessment (Appendix C, Table C3).

Certainty assessment

Overall, evidence of low to very low quality was identified. Among the 66 comparisons, 10 (15%) were of moderate quality, 37 (56%) were of low quality, and 19 (29%) were of very low quality. Imprecision and heterogeneity were the primary concerns that downgraded the confidence in the evidence. Additionally, some concerns regarding within-study bias and indirectness also contributed to the reduction in the overall confidence level. The lack of evidence of low quality for report bias may be due to the comprehensive search strategy covering multiple databases, as well as strict inclusion/exclusion criteria. There is no indirectness in any of the included studies, and it can be attributed to the similar distribution of effect modifiers across studies (ie, mean age, gender proportion). The overall certainty of evidence is presented in Appendix C, Table C4.

Discussion

According to the social ecological model, social participation improvement interventions applied diverse techniques to address complex barriers in participants' life situations, demonstrating their effectiveness in enhancing social participation. Pairwise meta-analysis indicated a positive and immediate influence on social participation at post-intervention, though short-, medium-, and long-term effects were not sustained at different follow-up times. Notably, results of the SUCRA ranking from the network meta-analysis revealed that personal-physical dimensional interventions had the greatest impact from baseline to post-intervention, with personal-interpersonal-physical dimensional interventions showing the second-strongest effect. As SUCRA reflects ranking probabilities rather than absolute effectiveness, it should be interpreted alongside effect sizes and confidence intervals. More high-quality interventions with larger sample sizes are needed in the future to verify the results.

This review is the first to classify social participation interventions using the 5 dimensions of the social ecological model. Previous reviews included various interventions and classified them based on the intervention types [24,29], or addressed domains of the ICF Activity and Participation [31]. The results of our review provided a clearer understanding of the primary components of social participation improvement interventions. A total of 9 interventions included in this review focused solely on resolving personal restrictions in participation, utilizing physical, cognitive, and behavioral training. In contrast, one third of the included interventions addressed organizational (n = 12) and physical environmental (n = 12) dimensional factors, while only a few interventions (n = 3) targeted barriers in the cultural/political dimension. In accordance with the findings of Lee's review [31], interventions that pay less attention to social, ecological, and cultural systems may fail to satisfy stroke survivors' complex needs for social interaction and work, limiting their ability to fully participate in society. Future studies should aim to design multi-dimensional interventions that provide comprehensive support from the micro-, meso-, and macro-systems.

In the pairwise meta-analysis, social participation improvement interventions displayed

an immediate effect on social engagement compared to control groups at post-intervention. This result provides preliminary evidence for the overall effectiveness of exercise, occupational therapy, or multi-dimensional interventions on social participation in the 32 included studies. Other narrative reviews have also indicated that diverse approaches can enhance social participation [24,29]. Our subgroup analyses in the pairwise meta-analysis indicated that interventions performed in Israel (pooled effect size = 0.67) and the UK (0.24), individual-based interventions (0.27), interventions lasting 8 weeks or longer (0.30), and three-dimensional interventions (0.41) showed a greater effect on social participation compared to their respective comparison groups. These findings could help guide researchers in designing future interventions. The relatively larger effect sizes (0.67) observed in interventions implemented in Israel may be related to cultural adaptation. For example, Harel-Katz et al. [62] conducted a culturally adapted, participation-focused self-management program for stroke survivors. The intervention provided information on local community resources and national policies, and the group discussions were also based on Israeli culture. By integrating culturally familiar content, the program may have improved participants' engagement and confidence in resuming social roles. However, this study found a non-significant effect of social participation improvement interventions at the short-, medium-, and long-term follow-up time, and the effect size diminished over time. The reasons are difficult to interpret due to different components based on the social ecological model were integrated in the included studies with longer follow-up durations. One reason might be that 7 of 8 included studies with longer follow-up duration were individual-based interventions; these interventions might not maintain a supportive group for improving long-term social participation. Another possible reason is the relatively short duration of interventions—5 out of the 8 included studies lasted less than 10 weeks. Such a limited timeframe may be insufficient to address multi-dimensional factors and to achieve sustained effects. Considering that the high heterogeneity among the included studies and limited benefits on improving social participation over time. Higher quality interventions are required, along with strengthened strategies to verify long-term benefits. Additionally, more trials with

similar follow-up periods are needed to confirm these observations.

Results from the network meta-analysis indicated that interventions combining personal and physical environmental dimensional techniques provided greater benefits for improving social participation from baseline to post-intervention compared with control groups (ie, usual care) or personal-organizational dimensional interventions. Interventions integrating personal, interpersonal, and physical environmental dimensions also showed a greater effect on participation from baseline to post-intervention compared with control groups or personal-organizational dimensional interventions. Single-dimensional interventions, such as functional training, focus on improving body function but have limitations in helping stroke survivors cope with real-life participation challenges, such as using public transportation. In contrast, bi-dimensional or multi-dimensional interventions integrate resources from different dimensions and can develop personalized strategies for specific activity participation [48]. Another strength is that several strategies, such as establishing supportive groups for experience sharing, acquiring information on community and social services, and creating home modification plans, are low-cost and easy to implement [70]. Bi- or multi-dimensional interventions might be especially practical for rural stroke survivors with limited resources for improving community participation.

There are several reasons why interventions combining personal-physical environmental dimensions or additionally incorporating interpersonal dimensional techniques have a greater effect on social participation. First, these types of interventions satisfy stroke survivors' needs for the recovery of social participation. Leisure therapy, for example, is suitable for stroke survivors who seek opportunities for leisure participation. Activities such as going out, exercising, and undertaking family roles are among the most restricted after a stroke [83,84]. Comprehensive interventions that integrate personal, interpersonal, and physical environmental resources could help stroke survivors actively participate in social interactions and outdoor activities. Second, impairment-based interventions, such as physical function training, help stroke survivors perform basic daily activities. In contrast, interventions that integrate physical and environmental dimensions are activity-based programs. According to

the ICF [33], social participation is influenced by both personal and environmental factors. Enhancing an individual's function and addressing the environmental barriers could promote greater social participation. For example, adjusting activities to suit the home or outside environment can promote participation recovery and increase the diversity of activities. Stroke survivors can adjust personal goals for participation flexibly, according to both personal function and environmental characteristics. Acquiring social support and balancing family relationships can also increase stroke survivors' autonomy in participation [84–87]. Third, the experience of falling and fear of falling (defined as a persistent concern about falling) [88] are commonly reported as limiting stroke survivors' outdoor participation [87,89]. Receiving assistance from family members and avoiding physical environmental obstacles often reduce falling incidences and, hence, alleviate fear of falling when engaging in outside activities.

Limitations and implications

Several limitations were noted, and the results of the systematic review and network meta-analysis should be interpreted with caution. First, several included interventions (eg, 5-dimensional interventions) only had a limited number of trials, which may have reduced the number of comparisons per category and affected the generalizability of the results. Second, the lack of direct comparisons between different interventions may limit the robustness of the results. Third, the imbalance in the number of comparisons between interventions may have reduced the statistical power. Fourth, heterogeneity between studies—due to differences in treatment dosage, stroke severity, delivery locations, and measurements of social participation—could affect the internal validity of the findings. However, we conducted sensitivity analyses and subgroup analyses to provide a stronger variance estimation. Fifth, due to language constraints, the search was limited to English and Chinese databases. Expanding the search to include other local-language databases (such as Korean-language databases) in future research may improve the cultural diversity and comprehensiveness of evidence on social participation interventions. Sixth, the overall confidence in the evidence

for most comparisons was assessed as low or very low due to factors such as imprecision and heterogeneity. The results should be considered with caution. Last, several control groups (eg, usual care, waiting-listed controls) were combined into a single group in the network meta-analysis to increase the number of studies available for analysis and broader comparisons. However, this method may enhance heterogeneity and reduce the validity of indirect comparisons. Future studies with higher quality and more diverse interventions, along with adequate sample sizes, are required to enhance the robustness of the results. Additionally, searching for multiple-language databases and including gray literature may also enhance the comprehensiveness and reduce potential publication bias.

This study offers practical insights for future social participation improvement interventions. First, it is essential for clinicians and researchers to shift from impairment-based to participation-based interventions to support personalized social participation goals. It is important for clinicians to evaluate restrictions related to social participation before discharge and provide tailored strategies, such as modifying the environment or using assistive tools. Second, multi-dimensional interventions, integrating personal, interpersonal, and environmental factors, may be more effective. For example, Wang et al. conducted a caregiver-mediated intervention that integrated functional training, task-specific exercises, social interaction, and environment-specific walking training for stroke survivors. The study reported positive effects on improving social participation [90]. Drawing from this case, future multi-dimensional interventions could benefit from a modular design that combines functional training, social support, and environmental adaptation strategies. Third, based on the social ecological model, multi-dimensional factors were interrelated and had a cumulative effect. Future intervention strategies can strengthen certain dimensional factors (ie, environmental factors) to enhance the overall effectiveness. Finally, a multidisciplinary team, connecting healthcare providers, community staff, and volunteers, could be established to implement community-based programs for social participation improvement.

Conclusions

This systematic review and network meta-analysis synthesized and compared the effectiveness of social participation interventions. Pairwise meta-analysis found immediate effectiveness in improving social participation, especially with individual-based interventions lasting 8 weeks or longer, and conducted in Israel and the UK. The network meta-analysis indicated that personal-physical environmental dimensional interventions were most effective in improving social participation among stroke survivors. Future studies should focus on rigorous, multi-dimensional interventions, incorporating organizational and political factors, to determine the most effective approaches for promoting social participation among stroke survivors.

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Declaration of competing interests

None

Credit information

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT 4.0 in order to check for any grammar or spelling errors. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication

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APPENDIX

Appendix A The PRISMA-NMA checklist

Appendix B Search strategies and results

Appendix C Supplementary references, tables and figures

FIGURE CAPTIONS

Fig. 1 The PRISMA flow diagram

Fig. 2 Network map of social participation comparisons in the network meta-analysis

Notes: Interventions were categorized into specific types according to the strategies they employed across the 5 dimensions of the social ecological model. For example, 'Per-Org' represents an intervention that incorporates personal and organizational strategies. Per-Env, personal-physical environmental dimensional intervention; Per-Int, personal-interpersonal dimensional intervention; Per-Int-Env, personal-interpersonal-physical environmental dimensional intervention; Per-Int-Org, personal-interpersonal-organizational dimensional intervention; Per-Int-Org-Env, personal-interpersonal-organizational-physical environmental dimensional intervention; Per-Int-Org-Pol, personal-interpersonal-organizational-political dimensional intervention; Per-Org, personal-organizational dimensional intervention; Per-Org-Env, personal-organizational-physical environmental dimensional intervention.

Fig. 3 Surface under the cumulative ranking curves (SUCRA) ranking of social participation interventions for stroke survivors

Notes: Interventions were categorized into specific types according to the strategies they employed across the 5 dimensions of the social ecological model. For example, 'Per-Org' represents an intervention that incorporates personal and organizational strategies. Per-Env, personal-physical environmental dimensional intervention; Per-Int, personal-interpersonal dimensional intervention; Per-Int-Env, personal-interpersonal-physical environmental dimensional intervention; Per-Int-Org, personal-interpersonal-organizational dimensional intervention; Per-Int-Org-Env, personal-interpersonal-organizational-physical environmental dimensional intervention; Per-Int-Org-Pol, personal-interpersonal-organizational-political dimensional intervention; Per-Org, personal-organizational dimensional intervention; Per-Org-Env, personal-organizational-physical environmental dimensional intervention.

Table 1 Characteristics of 32 included studies

First author, year, country	Mean age (years) (SD)/Median (IQR)		Sample size (n) (baseline) I/C	Social participation measurement	Intervention	Dimensions and techniques	Control	Follow-up
	I	C						
Dawson, 2024, Canada [48]	54.75 (11.78)	63.33 (12.00)	8/9	COPM, Performance	Personal-physical environmental dimension intervention	①goals-setting, a meta-cognitive strategy (Goal-Plan-Do-Check), goal attainment; ④application of strategies in a wide variety of everyday life situations.	Wait-list control with usual care	W0; W10
Chen, 2024, China [65]	64.8 (8.5)	59.0 (15.1)	14/13	COPM, Performance	Personal-physical environmental dimension intervention	①goal-directed IADL training; ④transportation appropriate training.	Health education	W0; W6
Forster, 2023, UK [56]	72 (11.0)	73 (12.0)	145/124	WHODAS 2.0	Personal-interpersonal dimension intervention	①needs assessment; problem solving, action planning, goal setting, self-management; ②social network evaluation and seeking help.	Usual care	M0; M3; M6; M9
Vluggen, 2021, Netherlands [66]	78.9 (7.0)	79.0 (6.5)	99/91	FAI	Personal-interpersonal-physical environmental dimension intervention	①inpatient neurorehabilitation treatment; self-management, home stroke education; mental health intervention; ②family communication and experience share; ④home visit and environment modification.	Usual care	M0; M6
Rooij, 2021, Netherlands [67]	65 (57-70)	61 (53-71)	28/24	USER-P	Technology-based therapy	①virtual reality gait training; goals-setting; adjusting multiple training options; training, real-time feedback.	Function rehabilitation therapy	W0; W6; M3
Adamit, 2021,	64.6	64.4	29/27	COPM,	Personal-physical	①problem identification and goals-setting, cognitive	Usual care	M0; W10;

Israel [61]	(8.2)	(10.8)		Performance	environmental dimension intervention	and behavioral strategies training, knowledge learning, self-efficacy enhancement; ④transportation appropriate training.		M6
Harel-Katz, 2020, Israel [62]	65 (52-75)	66 (45-87)	20/19	RNLI	Personal-interpersonal-organizational-political dimension intervention	①self-management, problem-solving and decision-making, improve self-efficacy, strategies learning; ②social support information; ③group discussions; community resources and association information; ⑤policies information.	Usual care	M0; M3
Morris, 2019, UK [57]	77.0 (9.1)	75.6 (8.8)	41/40	SIS participation	Personal-organizational dimension intervention	①goals-setting, art making; ③establish social connecting with group members.	Usual care	M0; M2; M3
Dehem, 2019, Belgium [68]	67.3 (11.1)	68.6 (19.1)	23/22	SIS participation	Technology-based therapy	①exercises on the robot, game training.	Function rehabilitation therapy	M0; W9; M5
Ahn, 2019, Korea [69]	64.9 (2.9)	66.4 (3.3)	23/20	COPM Performance	Personal-physical environmental dimension intervention	①goals setting, direct training, including physical and cognitive component training; ④environmental appropriate activity training.	Function rehabilitation therapy	W0; W6
Stark, 2018, USA [70]	66.89 (7.96)	64.67 (8.21)	9/6	RNLI	Personal-interpersonal-physical environmental dimension intervention	①activity training; self-management; motivational enhancement; ②caregiver activity training and problem-solving; ④home and the community environment assessment and modification.	Health education	M0; M6; M12
Brouwer, 2018, Canada [49]	62.7 (1.9)	62.1 (1.8)	51/52	SIPSO	Personal-organizational dimension intervention	①goals-setting, monitor mobility and activities training; ③education about community resources.	No intervention	M0; M3; M6; M9; M12; M15

Kessler, 2017, Canada [50]	71.0 (13.2)	64.9 (16.3)	10/11	RNLI	Personal-interpersonal dimension intervention	①education; meta-cognitive strategies: goals-setting, problem-solving, self-efficacy enhancement; ②support and encouragement to build social support.	Usual care	M0; M4; M6
Aidar, 2016, Brazil [71]	51.7 (8.0)	52.5 (7.7)	11/13	SF-36 social function	Function rehabilitation therapy	①one repetition maximum testing for load determination; warm-up: walking; strength training, adjust loads.	No intervention	M0; M3
Tomori, 2015, Japan [72]	68.26 (10.90)	64.19 (10.16)	27/27	SF-36, social function	Personal-physical environmental dimension intervention	①goals-setting, basic function exercises and simulated occupational practice; ④environment appropriate activities training.	Function rehabilitation therapy	M0; M2
Shin, 2015, Korea [73]	53.3 (11.8)	54.6 (13.4)	16/16	SF-36, social function	Technology-based therapy	①occupational therapy, training for ADL, and game-based VR rehabilitation.	Function rehabilitation therapy	M0; M1
McKellar, 2015, Canada [51]	57.70 (29-90)	58 (25-93)	39/38	RNLI	Personal-interpersonal-organizational-physical environmental-political dimension intervention	①stroke management; function evaluation; fall prevention, safe and depression management; ②social support; social network and relationships management; ③stroke services and group activities information; ④home environment and transportation ability evaluation and support; ⑤cultural and spiritual beliefs/activities needs.	Usual care	M0; M3
Mayo, 2015, Canada [52]	61 (12)	65 (11)	93/93	CHAMPS questionnaire	Personal-organizational dimension intervention	①aerobic exercise; goals setting; self-management; ③seeking community resources, group exercise, dancing and other activities.	Wait-list control with no intervention	M0; M3

Linder, 2015, USA [74]	55.5 (12.6)	59.4 (13.6)	51/48	SIS participation	Technology-based therapy	①functional, task-specific activities, robot-assisted spasticity reduction and motor training; function-based games.	Function rehabilitation therapy	M0; M2
Logan, 2014, UK [58]	71.7 (50.5)	71.5 (12.1)	287/281	SF-36 v2, social function	Personal-organizational-physical environmental dimension intervention	①standardized assessments, set plans, alleviating physical difficulties; overcoming psychological barriers; ③seeking community services; ④training of going outsides.	Health education	M0; M6; M12
Yuan, 2013, China [75]	70.0 (10.2)	70.0 (12.0)	29/27	Times on weekly leisure activities	Leisure therapy	①identify satisfied and restrictions in leisure activities, skills learning, limb activity and enhance self-efficacy.	Usual care	M0; M3
Rotenberg-Shpigelman, 2012, Israel [63]	65.5 (54-77)	65 (51-76)	12/11	COPM, Performance	Personal-interpersonal-physical environmental dimension intervention	①task-specific training; task adaptation; emotional barriers identification and motivation enhancement; ②social support; ④environmental modifications and adaptations, using assistive devices.	Wait-list control with usual care	M0; M3
Polatajko, 2012, Canada [53]	NA	NA	11/9	COPM Performance	Personal-physical environmental dimension intervention	①problem-solving; strategy identification, skill acquisition and change; ④environment appropriate skills learning.	Function rehabilitation therapy	NA
Lund, 2012, Norway [76]	75 (7.2)	79 (6.5)	39/47	SF-36, social function	Personal-interpersonal-organizational dimension intervention	①needs evaluations, life management, problem-solving, self-reflections, physical activity; ②peer support; ③group discussions, peer experience exchange.	Function rehabilitation therapy	M0; M9

Li, 2011, China [77]	NA	NA	50/50	SIS, participation	Personal-interpersonal-physical environmental dimension intervention	①SIS score-based targeted intervention, ADL rehabilitation, using devices, knowledge and psychological education; ②caregiver knowledge learning and skill training; ④using devices; refine home environment.	Usual care	M0; M1; M3
Markle-Reid, 2011, Canada [54]	75.8 (12.4)	70.6 (14.5)	43/39	SF-36, social function	Personal-interpersonal-organizational-physical environmental dimension intervention	①stroke education, case conferencing, communication, mobility, financial management; making plan; ②caregiver support, life roles change and social network enhancement; ③referral and linkage to health and social services; ④environment modification.	Usual care	M0; M12
Marsden, 2010, Australia [78]	70.0 (9.0)	73.1 (9.3)	12/13	SIS participation	Personal-interpersonal-organizational dimension intervention	①physical activity, health education, use affected arm; ②socially interaction, communication; ③group discussion, experience sharing and activities; access community resources.	Wait-list control with no intervention	W0; W9; W21
Harrington, 2010, UK [59]	71 (10.5)	70 (10.2)	119/124	SIPSO	Personal-interpersonal-organizational-political dimension intervention	①capacity and needs-based exercise, home exercise; ②support from family or other volunteers; ③group diverse sessions; ⑤provide local resources.	Usual care	W0; W9; M6; M12
Forster, 2009, UK [60]	77 (70-83)	79 (70-84)	132/133	FAI	Personal-interpersonal-organizational dimension intervention	①home stroke assessment, discussion and case review, and therapy; ②caregiver knowledge learning; ③acquiring community services.	Usual care	M0; M8
Desrosiers, 2007, Canada [55]	70.0 (10.2)	70.0 (12.0)	29/27	Number of participate in leisure activities	Leisure therapy	①empowerment, self-awareness, restrictions identify, and achieve autonomy in leisure activities.	Usual care	M0; M3

Katz-Leurer, 2003, Israel [64]	NA	NA	46/46	FAI	Function rehabilitation therapy	①regular therapy, stress test, individualized exercise prescription, monitor the heart rate.	Usual care	M0; M2; M6
Andersen, 2002, Denmark [79]	I1: 69.8 (9.9); I2: 74.1 (11.4)	68.3 (12.3)	54/53/48	FAI	I1: Personal-interpersonal-organizational dimension intervention I2: Personal-interpersonal dimension intervention	I1: physician-based: ①health status, social activity and family function discussion; ②caregiver knowledge learning, physician support; ③stroke clubs support, reference to stroke services or services. I2: physiotherapist-based: ①function evaluation, problem-solving; ②caregivers knowledge learning.	Usual care	M0; M6

ADL, activities of daily living; CHAMPS, Community Healthy Activities Model Program for Seniors; C, control; COPM, Canadian Occupational Performance Measure; FAI, Frenchay Activities Index; I, intervention; IADL, instrumental activities of daily living; IQR, interquartile range; M, month; RNLI, the Reintegration to Normal Living Index; SD, standard deviation; SF-36, Medical Outcomes Study 36-item Short-Form health survey; SIS: Stroke Impact Scale; SIPSO, Subjective Index of Physical and Social Outcome; USER-P, the Utrecht Scale for Evaluation of Rehabilitation-Participation; W, week; WHODAS 2.0, World Health Organization Disability Assessment Schedule 2.0.

Table 2 Intervention components identified in the 32 included studies

Dimensions	Intervention components
Personal	Stroke education, self-management, meta-cognitive strategies, function rehabilitation therapy (including functional training, exercise, and occupational therapy), stroke treatment, psychological management, leisure therapy, and life management.
Interpersonal	Enhancement of social support and social network, role conflict identification and solving, caregivers' education and skill training, communication, and experience sharing.
Organizational	Establish a communication and interaction group; acquire community and associations resources, health and social services; arrange group activities.
Physical environmental	Home and community environment evaluation and modification, environmental appropriate activity training, learn strategies to use transportation, and outside activity training.
Cultural and Political	Cultural and spiritual beliefs, provide local resources and policies, such as employment.

Table 3 League table shows the relative effect estimates of the included studies on improving social participation at post-intervention (n = 29).

Per-Env											
-0.03 (-0.76,0.71)	**Per-Int-Env**										
0.37 (-0.48,1.22)	0.40 (-0.46,1.25)	**LT**									
0.42 (-0.31,1.15)	0.44 (-0.44,1.32)	0.05 (-0.93,1.03)	**TBT**								
0.43 (-0.71,1.58)	0.46 (-0.68,1.60)	0.06 (-1.16,1.28)	0.01 (-1.22,1.25)	**Per-Int-Org-Pol**							
0.49 (-0.56,1.53)	0.51 (-0.53,1.56)	0.12 (-1.02,1.25)	0.07 (-1.08,1.22)	0.05 (-1.31,1.42)	**Per-Int-Org-Env**						
0.48 (-0.06,1.01)	0.50 (-0.23,1.23)	0.11 (-0.74,0.95)	0.06 (-0.43,0.55)	0.04 (-1.09,1.18)	-0.01 (-1.05,1.03)	**FRT**					
0.48 (-0.48,1.45)	0.51 (-0.46,1.48)	0.11 (-0.95,1.17)	0.07 (-1.01,1.15)	0.05 (-1.25,1.35)	-0.00 (-1.22,1.22)	0.01 (-0.95,0.97)	**Per-Org-Env**				
0.57 (-0.15,1.29)	0.60 (-0.18,1.38)	0.20 (-0.69,1.09)	0.15 (-0.65,0.96)	0.14 (-1.03,1.31)	0.09 (-0.99,1.16)	0.10 (-0.54,0.73)	0.09 (-0.91,1.09)	**Per-Int-Org**			
0.74 (-0.15,1.63)	0.77 (-0.13,1.66)	0.37 (-0.61,1.35)	0.32 (-0.69,1.33)	0.31 (-0.94,1.55)	0.25 (-0.90,1.41)	0.26 (-0.62,1.14)	0.25 (-0.83,1.34)	0.17 (-0.75,1.09)	**Per-Int**		
0.72 (0.20,1.25)	0.75 (0.23,1.27)	0.35 (-0.32,1.03)	0.31 (-0.40,1.02)	0.29 (-0.72,1.31)	0.24 (-0.67,1.15)	0.25 (-0.26,0.76)	0.24 (-0.58,1.06)	0.15 (-0.43,0.73)	-0.01 (-0.73,0.70)	**C**	
1.23 (0.50,1.97)	1.26 (0.52,1.99)	0.86 (0.01,1.71)	0.81 (-0.06,1.69)	0.80 (-0.34,1.94)	0.74 (-0.30,1.79)	0.75 (0.03,1.48)	0.75 (-0.22,1.71)	0.66 (-0.12,1.44)	0.49 (-0.39,1.38)	0.51 (-0.01,1.02)	**Per-Org**

Interventions were categorized into specific types according to the strategies they employed across the five dimensions of the social ecological model. For example, ‘Per-Org’ represents an intervention that incorporates personal and organizational strategies. C, control group; FRT, functional rehabilitation therapy; LT, leisure therapy; Per-Env, personal-physical environmental dimensional intervention; Per-Int, personal-interpersonal dimensional intervention; Per-Int-Env, personal-interpersonal-physical environmental dimensional intervention; Per-Int-Org, personal-interpersonal-organizational dimensional intervention; Per-Int-Org-Env, personal-interpersonal-organizational-physical environmental dimensional intervention; Per-Int-Org-Pol, personal-interpersonal-organizational-political dimensional intervention; Per-Org, physical-organizational dimensional intervention; Per-Org-Env, personal-organizational-physical environmental dimensional intervention; TBT, technology-based therapy.

Figure 1

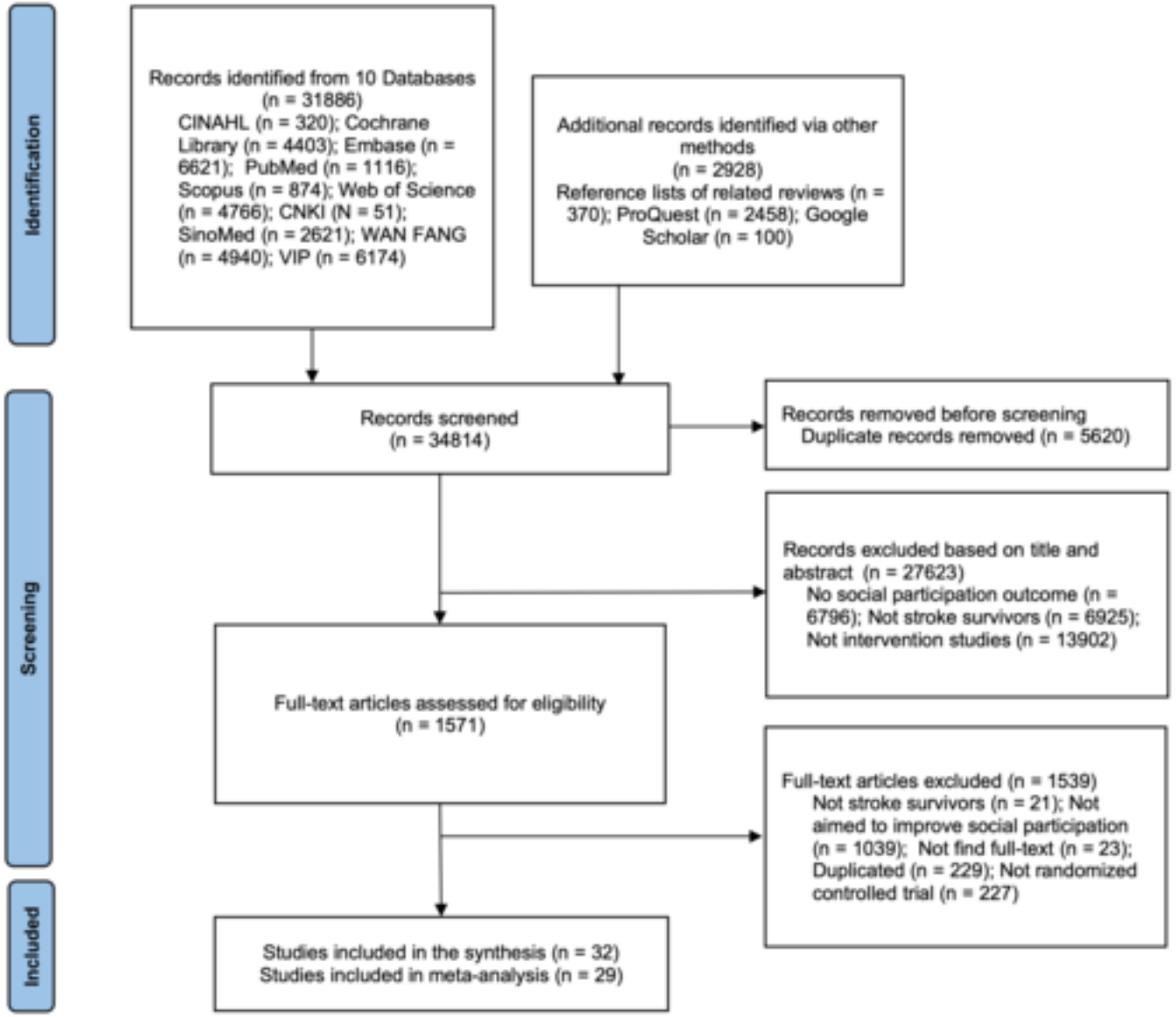


Figure 2

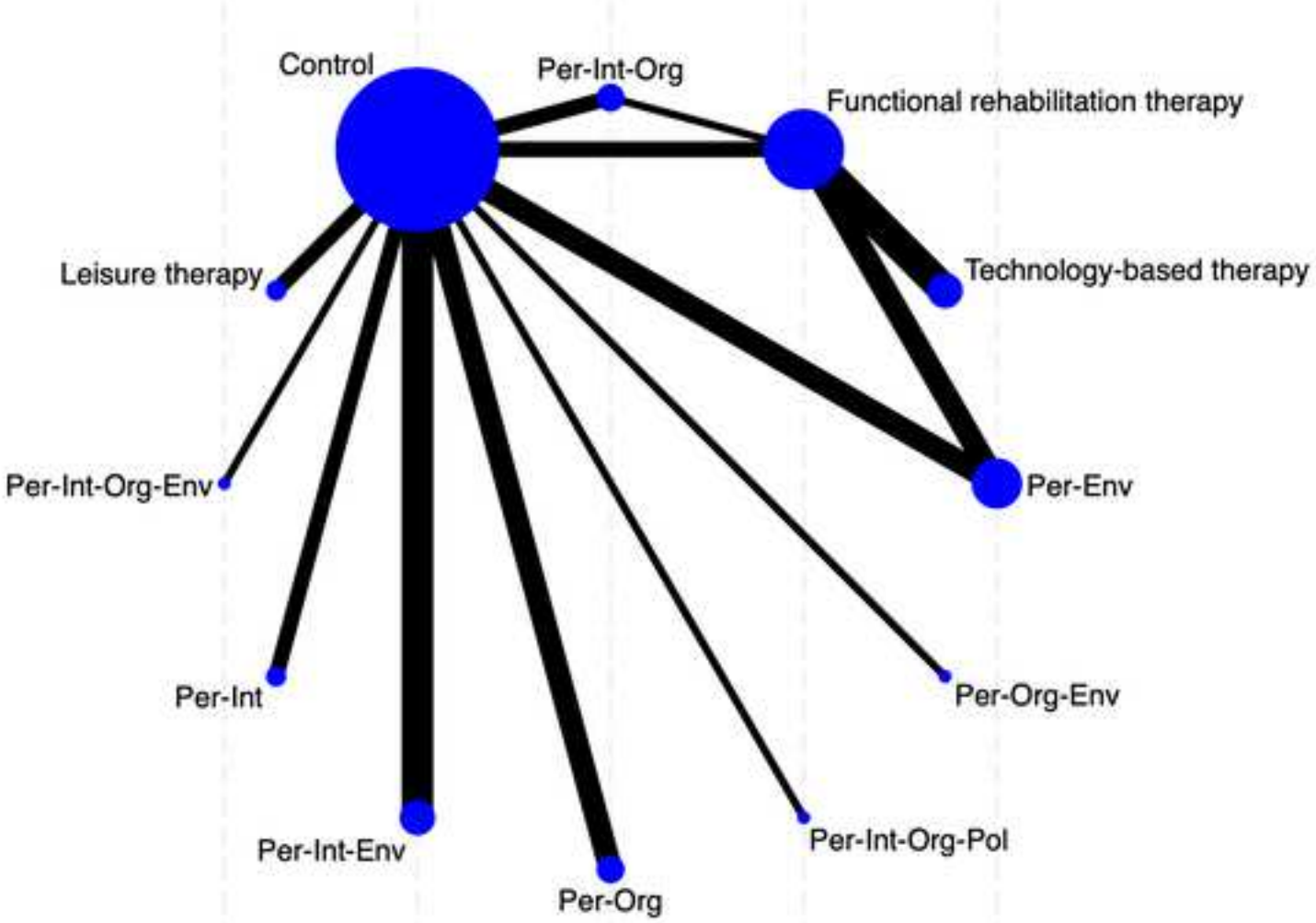
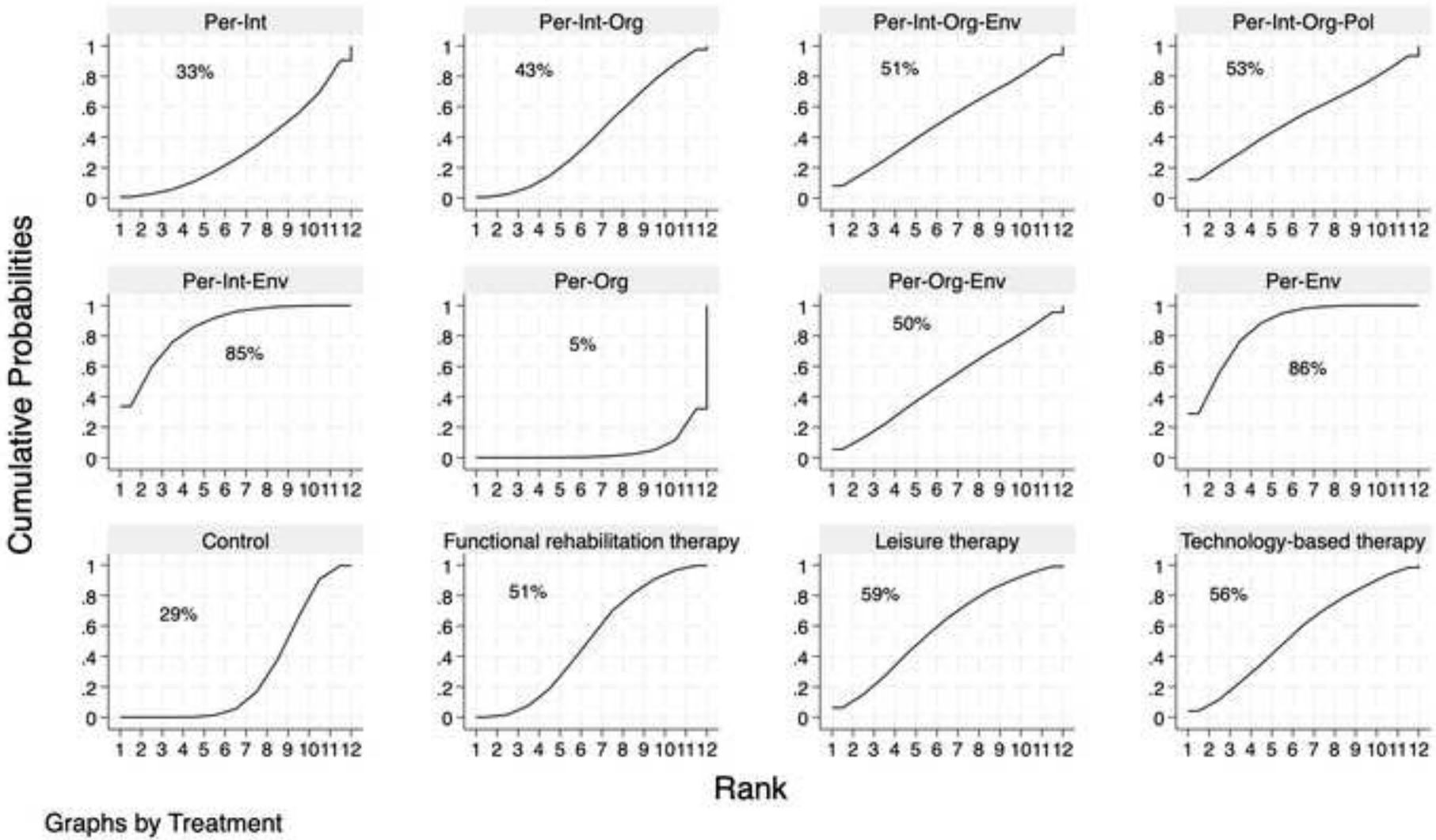


Figure 3



Appendix C

Appendix A The PRISMA NMA Checklist

Section/Topic	Item	Checklist Item	Reported on Page
TITLE			
Title	1	Identify the report as a systematic review *incorporating a network meta-analysis (or related form of meta-analysis).*	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: **Background:** main objectives **Methods:** data sources; study eligibility criteria, participants, and interventions; study appraisal; and *synthesis methods, such as network meta-analysis.* **Results:** number of studies and participants identified; summary estimates with corresponding confidence/credible intervals; *treatment rankings may also be discussed. Authors may choose to summarize pairwise comparisons against a chosen treatment included in their analyses for brevity.* **Discussion/Conclusions:** limitations; conclusions and implications of findings. **Other:** primary source of funding; systematic review registration number with registry name.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known, *including mention of why a network meta-analysis has been conducted.*	3-5
Objectives	4	Provide an explicit statement of questions being addressed, with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists and if and where it can be accessed (e.g., Web address); and, if available, provide registration information, including registration number.	5-6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. *Clearly describe eligible treatments included in the treatment network, and note whether any have been clustered or merged into the same node (with justification).*	6-7

Section/Topic	Item	Checklist Item	Reported on Page
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	6-7, Appendix B
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	8
Geometry of the network	**S1**	Describe methods used to explore the geometry of the treatment network under study and potential biases related to it. This should include how the evidence base has been graphically summarized for presentation, and what characteristics were compiled and used to describe the evidence base to readers.	10
Risk of bias within individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means). *Also describe the use of additional summary measures assessed, such as treatment rankings and surface under the cumulative ranking curve (SUCRA) values, as well as modified approaches used to present summary findings from meta-analyses.*	9-10
Planned methods of analysis	14	Describe the methods of handling data and combining results of studies for each network meta-analysis. This should include, but not be limited to: • *Handling of multi-arm trials;* • *Selection of variance structure;* • *Selection of prior distributions in Bayesian analyses; and* • *Assessment of model fit.*	9-10
Assessment of Inconsistency	**S2**	Describe the statistical methods used to evaluate the agreement of direct and indirect evidence in the treatment network(s) studied. Describe efforts taken to address its presence when found.	10

Section/Topic	Item	Checklist Item	Reported on Page
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses if done, indicating which were pre-specified. This may include, but not be limited to, the following: • Sensitivity or subgroup analyses; • Meta-regression analyses; • *Alternative formulations of the treatment network; and* • *Use of alternative prior distributions for Bayesian analyses (if applicable).*	9-10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	11, Figure 1
Presentation of network structure	**S3**	Provide a network graph of the included studies to enable visualization of the geometry of the treatment network.	Figure 2
Summary of network geometry	**S4**	Provide a brief overview of characteristics of the treatment network. This may include commentary on the abundance of trials and randomized patients for the different interventions and pairwise comparisons in the network, gaps of evidence in the treatment network, and potential biases reflected by the network structure.	14-16
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	12-13, Table 1 and Table C1
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment.	11-12, Figure C1 and C2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: 1) simple summary data for each intervention group, and 2) effect estimates and confidence intervals. *Modified approaches may be needed to deal with information from larger networks.*	14-16
Synthesis of results	21	Present results of each meta-analysis done, including confidence/credible intervals. *In larger networks, authors may focus on comparisons versus a particular comparator (e.g. placebo or standard care), with full findings presented in an appendix. League tables and forest plots may be considered to summarize pairwise comparisons.* If additional summary measures were explored (such	14-16, Table 3 and Figure C3

Section/Topic	Item	Checklist Item	Reported on Page
		as treatment rankings), these should also be presented.	
Exploration for inconsistency	**S5**	Describe results from investigations of inconsistency. This may include such information as measures of model fit to compare consistency and inconsistency models, *P* values from statistical tests, or summary of inconsistency estimates from different parts of the treatment network.	15
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies for the evidence base being studied.	11-12, Figure C1 and C2
Results of additional analyses	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression analyses, *alternative network geometries studied, alternative choice of prior distributions for Bayesian analyses,* and so forth).	None
DISCUSSION			
Summary of evidence	24	Summarize the main findings, including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy-makers).	17-20
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias). *Comment on the validity of the assumptions, such as transitivity and consistency. Comment on any concerns regarding network geometry (e.g., avoidance of certain comparisons).*	10-21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	21-22
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. This should also include information regarding whether funding has been received from manufacturers of treatments in the network and/or whether some of the authors are content experts with professional conflicts of interest that could affect use of treatments in the network.	Title page