Thieme

Effect of Community Exercise for Patients with Stroke: A Systematic Review and Meta-analysis

Wirkung von Sport in der Gruppe bei Schlaganfallpatienten: eine systematische Literaturrecherche und Meta-Analyse

Authors
Qi-feng Peng, Jie Zhou, Heng Jiang

Affiliation
Department of Rehabilitation, Chongqing Hospital of Traditional Chinese Medicine

Correspondence
Heng Jiang
No.6, Seven Branch Panxi Road,
Jiangbei District
400021 Chongqing City
pengqifeng06@163.com
1933286638@qq.com

ABSTRACT

Background Community exercise might be beneficial to stroke recovery. However, the results remained controversial. We conducted a systematic review and meta-analysis to explore the effect of community exercise on stroke patients.

Methods PubMed, EMbase, Web of science, EBSCO, and Cochrane library databases were systematically searched. Randomized controlled trials (RCTs) assessing the effect of community exercise vs. usual care on stroke were included. Two investigators independently searched articles, extracted data, and assessed the quality of included studies. The primary outcome were 6-Minute walk test and walking speed. Metaanalysis was performed using random-effect model.

Results Four RCTs involving 497 patients were included in the metaanalysis. Overall, compared with control intervention, community exercise intervention was found to significantly improve 6-Minute walk distance (Std. mean difference = 0.48; 95 % CI = 0.22 to 0.74; P = 0.0003), and walking speed (Std. mean difference = 0.40; 95 % CI = 0.10 to 0.70; P = 0.009) in stroke patients, but resulted in no influence on Berg Balance Scale (Std. mean difference = 0.39; 95 % CI = − 0.29 to 1.07; P = 0.26), muscle strength (Std. mean difference = 0.05; 95 % CI = -0.34 to 0.43; P = 0.82) and mental quality of life (Std. mean difference = 0.04; 95 % CI = − 0.25 to 0.34; P = 0.77).

Conclusions Compared to control intervention, community exercise was found to significantly increase 6-Minute walk test, walking speed and Berg Balance Scale, but showed no influence on Berg Balance Scale, muscle strength and mental quality of life.

ZUSAMMENFASSUNG

Hintergrund Sport in der Gruppe kann sich positiv auf den Heilungsverlauf nach einem Schlaganfall auswirken. Die Ergebnisse sind jedoch umstritten. Wir haben eine systematische Literaturrecherche und Meta-Analyse durchgeführt, um die Wirkung von Sport in der Gruppe bei Schlaganfallpatienten zu untersuchen.

Methoden Es wurde eine systematische Literaturrecherche in PubMed, EMbase, Web of science, EBSCO und der Cochrane library Datenbank durchgeführt. Darin eingeschlossen waren randomisierte Studien (RCTs), in der die Wirkung von Sport in der Gruppe vs. herkömmliche Maßnahmen bei Schlaganfallpatienten untersucht wurde. Zwei Untersucher recherchierten unabhängig voneinander Artikel, extrahierten Daten und bewerteten die Qualität der eingeschlossenen Studien. Primäre Zielgrößen waren der 6-Minuten-Gehtest und Gehgeschwindigkeit. Die Meta-Analyse wurde mithilfe von Datenmodellen mit zufälligen Effekten durchgeführt.

Ergebnisse In der Meta-Analyse wurden 4 RCTs untersucht, an denen 497 Patienten teilgenommen hatten. Insgesamt konnte festgestellt werden, dass Sport in der Gruppe im Vergleich zu herkömmlichen Maßnahmen die Distanz beim 6-Minuten-Gehtest bei Schlaganfallpatienten signifikant verbesserte (Standardabweichung mittlere Differenz = 0,48; 95 % CI = 0,22– 0,74;

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P = 0,0003), ebenso die Gehgeschwindigung (Standardabweichung mittlere Differenz = 0,40; 95 % CI = 0,10–0,70; P = 0,009), jedoch konnte kein Unterschied bei der Berg-Balance-Skala (Standardabweichung mittlere Differenz = 0,39; 95 % CI = −0,29 bis 1,07; P = 0,26), der Muskelkraft (Standardabweichung mittlere Differenz = 0,05; 95 % CI = −0,34 bis 0,43; P = 0,82) und der mentalen Lebensqualität (Standardabweichung mittlere

Differenz = 0,04; 95 % CI = −0,25 bis 0,34; P = 0,77) festgestellt werden.

Schlussfolgerung Im Vergleich zu herkömmlichen Maßnahmen konnte mit Sport in der Gruppe eine signifikante Verbesserung des 6-Minuten-Gehtests und der Gehgeschwindigkeit erzielt werden, es zeigte sich jedoch keine Wirkung auf der Berg-Balance-Skala, der Muskelkraft und mentalen Lebensqualität.

Introduction

Stroke was known as the leading cause of adult disability and resulted in great social burden [1, 2]. Approximately a third of stroke patients suffered from the recurrence of stroke, and 75 % of them had cardiac disease [3, 4]. Many stroke survivors wanted to return to independent living and to achieve a good quality of life [5]. The onset of stroke was sudden, and it was ill-prepared to deal with the sequelae for the individual and the family [6, 7].

It was urgent and important to develop practical interventions in order to reduce disability levels and prevent stroke recurrence and cardiovascular disease [8]. Stroke recurrence was influenced by various modifiable metabolic risk factors such as impaired glucose control, dyslipidemia, hypertension, obesity, and low cardiorespiratory fitness, which resulted in the damage of the structure and function of blood vessels [9–12]. The increase in physical activity was reported to be the inexpensive, safe, and effective method of improving metabolic risk factors and vascular control [13, 14]. Structured community exercise resulted in short- and long-term functional benefits post stroke [15]. Some randomized controlled trials (RCTs) demonstrated that community exercise could significantly increase 6-Minute walk distance, walking speed and improve balance in stroke patients [16, 17].

In contrast to this promising finding, however, some relevant RCTs showed that community exercise had no influence on walking speed, muscle strength and mental quality of life for stroke patients [17, 18]. Considering these inconsistent effects, we therefore conducted a systematic review and meta-analysis of RCTs to evaluate the effectiveness of community exercise in patients with stroke.

Materials and methods

This systematic review and meta-analysis were conducted according to the guidance of the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement [19] and the Cochrane Handbook for Systematic Reviews of Interventions[20]. All analyses were based on previous published studies, thus no ethical approval and patient consent were required.

Literature search and selection criteria

PubMed, EMbase, Web of science, EBSCO, and the Cochrane library were systematically searched from inception to July 2017, with the following keywords: community exercise, and stroke. No limitation was enhanced. To include additional eligible studies, the reference lists of retrieved studies and relevant reviews were also hand-searched and the process above was performed repeatedly until no

further article was identified. Conference abstracts meeting the inclusion criteria were also included.

The inclusion criteria were as follows: study population, patients with stroke; intervention, community exercise; control, usual care; outcome measure, 6-Minute walk test and walking speed; and study design, RCT.

Data extraction and outcome measures

The following information was extracted for the included RCTs: first author, publication year, sample size, baseline characteristics of patients, community exercise, control, study design, 6-Minute walk test, walking speed, Berg Balance Scale, muscle strength and mental quality of life. The author would be contacted to acquire the data when necessary.

The primary outcomes were 6-Minute walk test and walking speed. Secondary outcomes included Berg Balance Scale, muscle strength and mental quality of life. 6-Minute walk test served as a reliable method to assess walking performance in individuals with stroke through recording the distance walked in 6 min [21]. Berg Balance Scale (maximal score = 56) was applied to assess the functional balance in older adults [22].

Quality assessment in individual studies

The Jadad Scale was used to evaluate the methodological quality of each RCT included in this meta-analysis [23]. This scale consisted of 3 evaluation elements: randomization (0–2 points), blinding (0–2 points), dropouts and withdrawals (0–1 points). One point would be allocated to each element if they have been mentioned in article, and another one point would be given if the methods of randomization and/or blinding had been detailedly and appropriately described. If methods of randomization and/or blinding were inappropriate, or dropouts and withdrawals had not been recorded, then one point was deducted. The score of Jadad Scale varied from 0 to 5 points. An article with Jadad score ≤ 2 was considered to be of low quality. If the Jadad score ≥ 3, the study was thought to be of high quality [24].

Statistical analysis

Standard Mean differences (Std. MDs) with 95 % confidence intervals (CIs) for continuous outcomes (6-Minute walk test, walking speed, Berg Balance Scale, muscle strength and mental quality of life) were used to estimate the pooled effects. All meta-analyses were performed using random-effects models with DerSimonian and Laird weights. Heterogeneity was tested using the Cochran Q statistic ($p < 0.1$) and quantified with the I^2 statistic, which described the varia-

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tion of effect size that was attributable to heterogeneity across studies. An I^2 value greater than 50% indicated significant heterogeneity. Sensitivity analysis was performed to detect the influence of a single study on the overall estimate via omitting one study in turn when necessary. Owing to the limited number (<10) of included studies, publication bias was not assessed. $P < 0.05$ in 2-tailed tests was considered statistically significant. All statistical analyses were performed with Review Manager Version 5.3 (The Cochrane Collaboration, Software Update, Oxford, UK).

Results

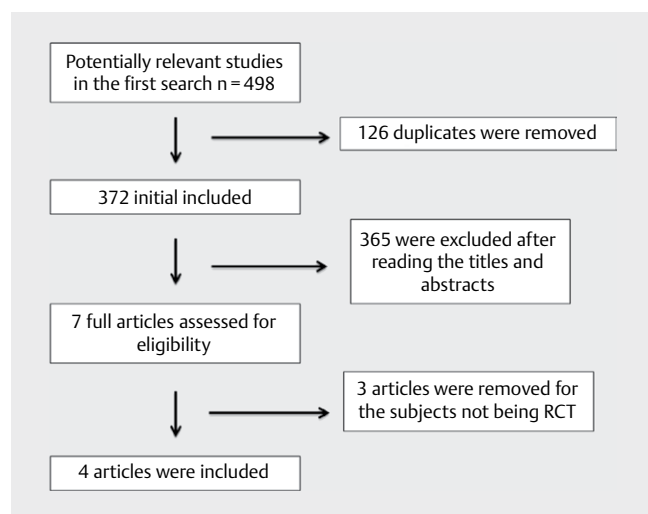## Literature search, study characteristics and quality assessment

The flow chart for the selection process and detailed identification was presented in ▶ **Fig. 1**. 498 publications were identified through the initial search of databases. Ultimately, 4 RCTs were included in the meta-analysis [16–18, 25].

The baseline characteristics of the 4 eligible RCTs in the meta-analysis were summarized in ▶ **Table 1**. The 4 studies were published between 2005 and 2015, and sample sizes ranged from 40 to 232 with a total of 497. There were no significant difference of age, time since stroke and Mini Mental State Examination between community exercise group and control group at baseline.

Among the 4 RCTs, 3 studies reported the 6-Minute walk test [16–18], 2 studies reported the walking speed [16, 17], 2 studies reported the Berg Balance Scale [16, 18], 2 studies reported the muscle strength [16, 18] and 2 studies reported the mental quality of life [16, 17]. Jadad scores of the 4 included studies varied from 3 to 5, and all 4 studies were considered to be high-quality ones according to quality assessment.

## Primary outcome: 6-Minute walk test, and walking speed

These 2 outcome data were analyzed with the random-effects model. In ▶ **Fig. 2**, "Dean 2012" represented the data of 6-Minute walk test among faster walker of stroke patients, and "Dean



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│ Potentially relevant studies    │
│ in the first search n = 498     │
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              ▼                   │ 126 duplicates were removed  │
┌─────────────────────────────────┐  └──────────────────────────────┘
│ 372 initial included            │
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              │          ──────►  ┌──────────────────────────────┐
              ▼                   │ 365 were excluded after      │
┌─────────────────────────────────┐  │ reading the titles and      │
│ 7 full articles assessed for    │  │ abstracts                    │
│ eligibility                     │  └──────────────────────────────┘
└─────────────────────────────────┘
              │          ──────►  ┌──────────────────────────────┐
              ▼                   │ 3 articles were removed for  │
┌─────────────────────────────────┐  │ the subjects not being RCT  │
│ 4 articles were included        │  └──────────────────────────────┘
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▶ **Fig. 1** Flow diagram of study searching and selection process.

▲ **Table 1** Characteristics of included studies.

| NO.	Author	Community exercise group						Control group						Jadad scores
		Number	Age (years)	Male (n)	Hemorrhagic stroke/Ischemic stroke (n)	Time since stroke	Mini Mental State Examination	Number	Age (years)	Male (n)	Hemorrhagic stroke/Ischemic stroke (n)	Time since stroke	Mini Mental State Examination	
1	Moore 2015	20	68±8	18	1/19	21±34 months	28±2	20	70±11	16	2/18	16±12 months	29±1	4
2	Dean 2012	76	66.7±14.3	38	–	6.7±6.7 years	27±3	75	67.5±10.2	40	–	5.2±5.4 years	27±3	5
3	Harrington 2010	119	70±10.2	67	–	–	–	124	71±10.5	65	–	–	–	3
4	Pang 2005	32	65.8±9.1	19	14/18	–	27.6±2.3	31	64.7±8.4	18	12/19	–	28.2±1.9	4
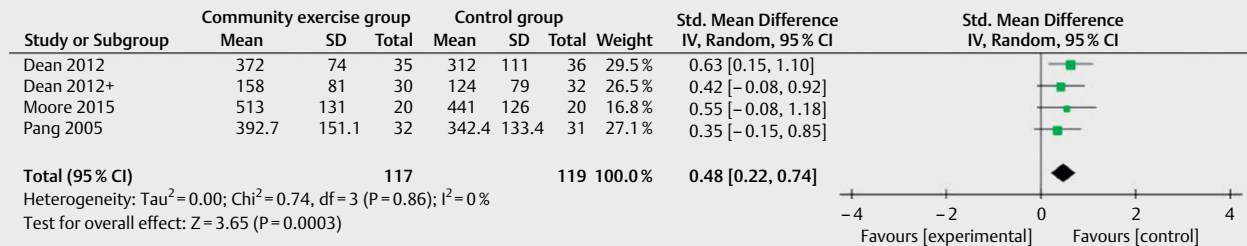
Fig. 2   Forest plot for the meta-analysis of 6-Minute walk test (m).
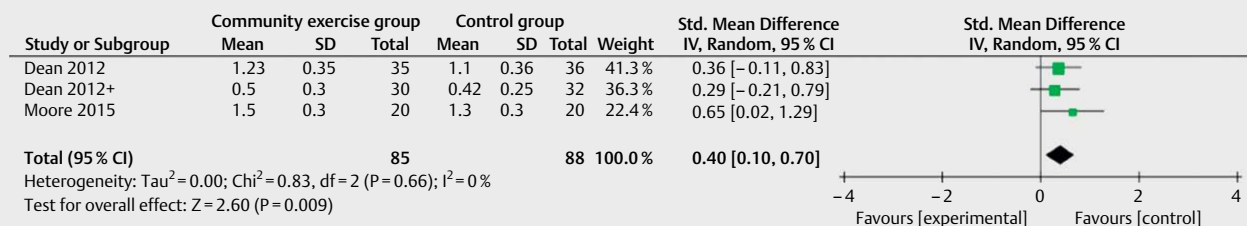
Fig. 3   Forest plot for the meta-analysis of walking speed (m/s).
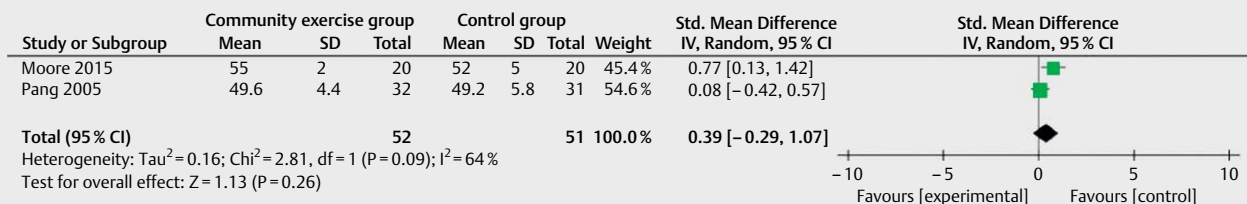
Fig. 4   Forest plot for the meta-analysis of Berg Balance Scale.

2012 + " represented the data of 6-Minute walk test among slower walker of stroke patients [17]. Similarly, "Dean 2012" and "Dean 2012 + " represented the data of walking speed in the same study in ▶ **Fig. 3**. The pooled estimate of the 3 included RCTs suggested that compared to control group, community exercise intervention was associated with a significantly increased 6-Minute walk distance (Std. mean difference = 0.48; 95 % CI = 0.22–0.74; P = 0.0003), with no heterogeneity among the studies ($I^2 = 0$ %, heterogeneity P = 0.86, ▶ **Fig. 2**). Consistently, community exercise could significantly improve walking speed (Std. mean difference = 0.40; 95 % CI = 0.10–0.70; P = 0.009) compared to control group, with no heterogeneity among the studies ($I^2 = 0$ %, heterogeneity P = 0.66, ▶ **Fig. 3**).
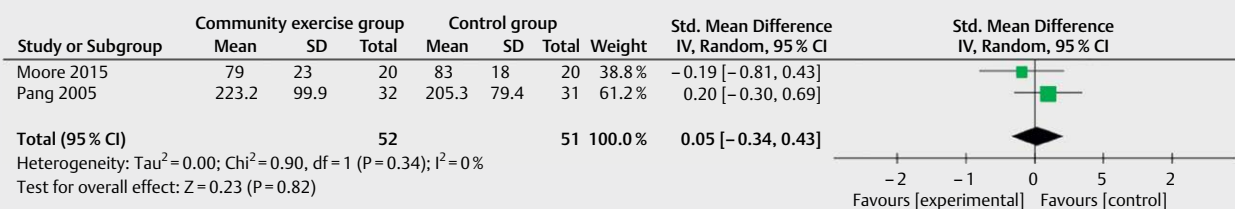
Sensitivity analysis

No heterogeneity was observed among the included studies for the 6-Minute walk test, and walking speed. Thus, we did not perform sensitivity analysis by omitting one study in each turn or perform subgroup analysis to detect the source of heterogeneity.
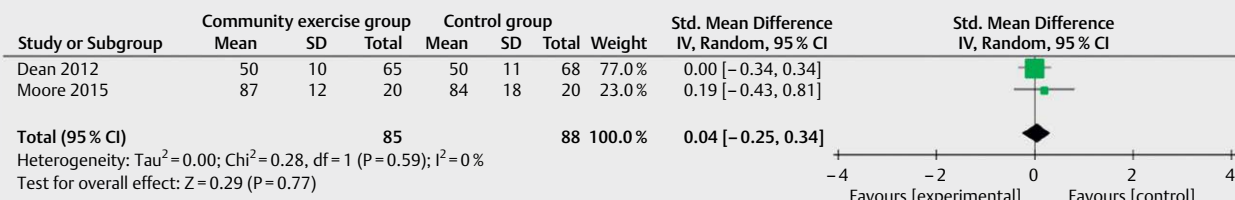
Secondary outcomes

Compared with control intervention in stroke patients, community exercise showed no substantial influence on Berg Balance Scale (Std. mean difference = 0.39; 95 % CI = − 0.29 to 1.07; P = 0.26; ▶ **Fig. 4**), muscle strength (Std. mean difference = 0.05; 95 % CI = − 0.34 to 0.43; P = 0.82; ▶ **Fig. 5**) and mental quality of life (Std. mean difference = 0.04; 95 % CI = − 0.25 to 0.34; P = 0.77; ▶ **Fig. 6**).

Discussion

In our meta-analysis, community exercise led to clinically significant improvements in 6-Minute walk test, and walking speed in stroke patients, but showed no substantial effect on Berg Balance Scale, muscle strength or mental quality of life. To our knowledge, this was the first meta-analysis to investigate the efficacy of community-based exercise in stroke patients. Additionally, quality of life increased in terms of mood and physical functioning [26, 27]. Improved cognition was revealed after community exercise, which was in line with previous interventional studies in healthy individuals [16, 28]. No participants experienced any adverse events in the included RCTs.

Study or Subgroup	Community exercise group			Control group			Weight	Std. Mean Difference IV, Random, 95 % CI	Std. Mean Difference IV, Random, 95 % CI
	Mean	SD	Total	Mean	SD	Total			
Moore 2015	79	23	20	83	18	20	38.8 %	−0.19 [−0.81, 0.43]	
Pang 2005	223.2	99.9	32	205.3	79.4	31	61.2 %	0.20 [−0.30, 0.69]	
Total (95 % CI)			52			51	100.0 %	0.05 [−0.34, 0.43]	

Heterogeneity: Tau^2 = 0.00; Chi^2 = 0.90, df = 1 (P = 0.34); I^2 = 0 %
Test for overall effect: Z = 0.23 (P = 0.82)

▶ **Fig. 5** Forest plot for the meta-analysis of muscle strength (N).

Study or Subgroup	Community exercise group			Control group			Weight	Std. Mean Difference IV, Random, 95 % CI	Std. Mean Difference IV, Random, 95 % CI
	Mean	SD	Total	Mean	SD	Total			
Dean 2012	50	10	65	50	11	68	77.0 %	0.00 [−0.34, 0.34]	
Moore 2015	87	12	20	84	18	20	23.0 %	0.19 [−0.43, 0.81]	
Total (95 % CI)			85			88	100.0 %	0.04 [−0.25, 0.34]	

Heterogeneity: Tau^2 = 0.00; Chi^2 = 0.28, df = 1 (P = 0.59); I^2 = 0 %
Test for overall effect: Z = 0.29 (P = 0.77)

▶ **Fig. 6** Forest plot for the meta-analysis of mental quality of life.

Community-based exercise therapy was reported to be a feasible method of modifying metabolic risk factors [29, 30]. A 23 % increase (0.3 mmol/L) of high-density lipoprotein cholesterol (HDL-C) was revealed after exercise. 0.06 mmol/L increase of HDL-C led to a 6 % reduction in coronary heart disease, and 75 % of stroke survivors had cardiac disease [31–33]. However, exercise showed no influence on lipid profile, cholesterol and low-density lipoprotein cholesterol (LDL-C) [34, 35].

Previous study showed that community-based exercise might showed significant influence on glucose control in type 2 diabetes mellitus (T2DM) or impaired glucose tolerance (IGT) patients, but had no substantial effect on glucose control in patients without T2DM or IGT. Possibly because study participants had adequate glucose control [36]. The brain imaging data demonstrated that in stroke patients, medial temporal lobe tissue structure was maintained, and regional blood flow was increased after exercise intervention. In contrast, significant atrophy of the medial temporal lobe was found in the control group. This area with the increase in regional blood flow after exercise might be associated with cognition, indicating that exercise was a possible means of ameliorating atrophy post-stroke and improving long-term cognition [16, 37, 38].

Exercise therapy was reported to produce significant short-term improvements in cardiorespiratory fitness (the increase by 17 %, 3 mL/kg/min), lipid profile, and blood pressure. These could potentially enable individuals with stroke to sustain light activities of daily living and undertake more vigorous activities [39, 40]. The reduction in diastolic blood pressure of 4 mm Hg could reduce the relative risk of recurrent stroke by 28 %, and exercise reduced diastolic blood pressure by 3 mm Hg [41, 42].

Several limitations should be taken into account. Firstly, our analysis was based on 4 RCTs but 2 of them have a relatively small sample size (n < 100). Overestimation of the treatment effect was more likely in smaller trials compared with larger samples. More clinical trials with large sample were needed to explore this issue.

Stroke participants only had mild-moderate deficit in included RCTs, and the influence of community exercise on stroke patients with serious deficit was not clear. It was difficult to perform subgroup analysis based on hemorrhagic stroke and ischemic stroke which might have different pooling results. Finally, some unpublished and missing data might lead bias to the pooled effect.

Conclusion

Community exercise showed an important ability to improve 6-Minute walk test, and walking speed in stoke patients. Community exercise was recommended to be administrated for stoke.

Conflicts of Interest

The authors declare no conflict of interest.

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