

Climbing for preventing and treating health problems: a systematic review of randomized controlled trials

Klettern zur Vorbeugung und Behandlung von Erkrankungen: eine systematische Übersicht randomisierter kontrollierter Studien

Abstract

Objective: To summarize the best available evidence on effectiveness of therapeutic or sport climbing in preventing or treating health problems.

Methods: We searched Medline, Embase, CENTRAL, PsycINFO, PEDro, OTseeker and SportDiscus for randomized controlled trials published up to December 26, 2010. We included all trials assessing patient-relevant outcomes. Two reviewers independently selected relevant studies, assessed their methodological quality and extracted data. Quality of evidence was rated using the GRADE system. Data were entered into RevMan 5 to calculate effect sizes and 95% confidence intervals where appropriate.

Results: Eligible for inclusion were four RCTs studying the effectiveness of climbing in (a) geriatric patients, (b) adults with multiple sclerosis, (c) adults with chronic low-back pain and (d) children with disabilities and poor motor function. The sample sizes ranged between 20 and 95. All trials had major methodological limitations. We found very low quality evidence that therapeutic climbing may improve activities of daily living in geriatric patients compared to physiotherapy as measured by the Barthel index (difference in mean change score: 2.32 [95%-CI: 0.45 to 4.19]). We found very low quality evidence that therapeutic climbing compared to standard exercise therapy may improve physical functioning (difference in mean change score: 16.15 [95%-CI: 4.45 to 27.85]) and general physical health (13.14 [95%-CI: 3.61 to 22.67]) as measured by the SF-36 in adults with chronic low back-pain.

Conclusions: Evidence for the effectiveness of therapeutic climbing is limited to small trials at high risk of bias. The effects of therapeutic climbing are therefore unclear.

Keywords: mountaineering, exercise therapy, rehabilitation

Zusammenfassung

Ziel: Die bestverfügbare Evidenz zur Wirksamkeit des therapeutischen oder Sportkletterns in der Vorbeugung oder Behandlung von Erkrankungen darzustellen.

Methodik: Wir haben Medline, Embase, CENTRAL, PsycINFO, PEDro, OTseeker and SportDiscus nach randomisierten kontrollierten Studien durchsucht (Suchdatum: 26. Dezember 2010). Wir haben Studien eingeschlossen, die patientenrelevante Endpunkte untersucht haben. Zwei Reviewer haben unabhängig voneinander relevante Artikel ausgewählt, ihre methodische Qualität bewertet und Daten extrahiert. Die Qualität der Evidenz wurde anhand des GRADE Systems bewertet. Mittels RevMan 5 wurden Effektstärken und dazugehörige 95% Konfidenzintervalle (KI) ermittelt, sofern adäquat.

Ergebnisse: Vier randomisierte Studien haben die Einschlusskriterien erfüllt: Studien zur Wirksamkeit des Kletterns bei (a) geriatrischen Pati-

Roland Brian Buechter¹
Dennis Fachtelpeter¹

¹ Institute for Quality and Efficiency in Health Care (IQWiG), Köln, Germany

enten, (b) Erwachsenen mit Multipler Sklerose, (c) Erwachsenen mit chronischen Rückenschmerzen und (d) Kindern mit Behinderungen und motorischen Störungen. Die Studiengröße lag zwischen 20 und 95. Alle Studien hatten erhebliche methodische Limitierungen. Wir fanden Evidenz von sehr niedriger Qualität, dass therapeutisches Klettern bei geriatrischen Patienten im Vergleich zu Physiotherapie Aktivitäten des täglichen Lebens verbessern könnte (Differenz der Mittelwerte zwischen Baseline und Follow-Up im Barthel-Index: 2.32 [95%-KI: 0.45 to 4.19]). Darüber hinaus fanden wir Evidenz sehr niedriger Qualität, dass therapeutisches Klettern im Vergleich zu herkömmlicher Bewegungstherapie gemessen am SF-36 die körperliche Funktion (Differenz der Mittelwerte zwischen Baseline und Follow-Up: 16.15 [95%-KI: 4.45 to 27.85]) und allgemeine körperliche Gesundheit (13.14 [95%-KI: 3.61 to 22.67]) bei Erwachsenen mit chronischen Rückenschmerzen verbessern könnte. Schlussfolgerung: Die Evidenz zur Wirksamkeit von Klettern beschränkt sich auf kleine Studien mit erheblichen methodischen Limitierungen. Die Wirkung des Kletterns zur Vorbeugung oder Behandlung von Erkrankungen ist daher unklar.

Schlüsselwörter: Klettern, Bewegungstherapie, Rehabilitation

Introduction

The popularity of recreational sport climbing is increasing. Climbing is also being used therapeutically in different contexts and, particularly in Germany, has received increasing attention lately [1]. Therapeutic climbing does not necessarily involve climbing routes as done in sport climbing, but may only involve specific exercises performed on a climbing wall. To differentiate between these climbing types we will speak of sport climbing or therapeutic climbing in the following.

Sport climbing is usually learned in an indoor climbing gym where artificial walls are used to mimic rock climbing in a safe environment. Top-ropeing, which is the psychological and physically least demanding climbing style, can easily be learned in a short introductory course that usually lasts about two hours and provides basic climbing skills and the necessary safety information, in particular how to put on the climbing harness correctly, how to tie into the rope, how to use the belay device and how to communicate with the climbing partner.

Therapeutic climbing involves specific climbing exercises that may be used as a strengthening exercise or a means of mobilization. It may be considered as a type of bouldering, a climbing style where routes no higher than 3 to 5 meters are climbed without a rope. To prevent injuries from falling, a mat is placed on the ground and a second person is usually situated behind the climber to guide him in case of a fall. The spotter can also provide reassurance and support by placing his hands on the back of the climber, if needed. Bouldering can also take place at much lower heights just above the ground, where routes are climbed sideways, which is likely to be done in a therapeutic context [1].

Exercise is generally associated with positive mental health outcomes [2],[3]. Sport climbing, in particular, could have beneficial effects because it is aimed at a very specific goal (reaching the top) which can be accom-

plished in a short period of time and may elicit strong feelings of having mastered a difficult task. Resulting success experiences may increase confidence and self-efficacy. Furthermore pairs of people are needed in sport climbing (the climber and the belayer) and a certain amount of trust has to be built between these persons. The social contact may play an important role for psychological well-being. Changes in endorphins and monoamine levels also provide a plausible mechanism for beneficial psychological effects of exercise [4].

It has been argued that climbing may be useful in neurological rehabilitation since complex cognitive problems have to be solved due to constantly changing sequences of movements [1]. It has also been used to improve gait balance in order to prevent falls in the elderly and to improve flexibility, stability and strength in people with multiple sclerosis [5], [6]. Climbing may also increase strength of the spinal muscles and improve muscular balance [7]. An advantage of climbing could be that it may be more exciting than other types of physical or exercise therapies because of its adventurous component, resulting in higher levels of adherence. The aim of this review is to determine the effects of sports climbing or therapeutic climbing for preventing or treating health problems. The review is reported in accordance with the PRISMA statement [8].

Methods

Data sources and search strategy

We searched MEDLINE, CENTRAL, EMBASE, PsycINFO, SportDISCUS, OTseeker and PEDro from inception of the database or in case of PsycINFO from 1950 up to the 22nd of December 2010. We combined relevant search terms with search filters for retrieving randomized controlled trials where appropriate and available [9], [10],

[11]. Search terms included the truncated keywords climb* and boulder* as well as relevant subject headings such as mountaineering and rock climbing. The search terms were combined with the Boolean operator “or”. We also unsystematically searched Google and screened the reference lists of included studies in order to find additional trials. Both authors independently screened all articles by title and abstract. Full-texts of potentially relevant articles were retrieved and independently reviewed for eligibility by both authors. Disagreements were resolved by arbitration with a third person.

Study selection

We included randomized controlled trials that compared therapeutic or sport climbing with any type of control group (e.g. no-treatment, wait-list, active). Climbing could be used as a sole or adjunctive treatment, as long as experimental and control groups received the same care apart from the intervention under study. Studies of patients with any kind of health problem including somatic and psychiatric illnesses or any kind of symptoms were included. We also included trials testing the prophylactic effect of climbing on healthy participants. We excluded studies where climbing was used as a component of a multi-faceted intervention, because this makes it impossible to distinguish the effects of climbing from other components of the intervention. We excluded studies only published as conference abstracts, as assessment of eligibility, methods and results is not possible.

Since our review is not specific to one indication, it was difficult to predefine outcomes. We therefore included all outcomes that we considered patient relevant. Where this was controversial, we were generally inclusive. Surrogate outcomes such as physiological measurements were excluded, since the clinical relevance of such measurements is often unclear [12].

Assessment of study limitations

We assessed the risk of bias of the included studies, using the following criteria from the Cochrane risk of bias tool: random sequence generation, allocation concealment, blinding, adequate handling of missing outcome data, selective outcome reporting and other potential biases [13]. We rated the overall quality of the evidence into four categories (high, moderate, low, very low) using the criteria proposed by the GRADE working group [14]. These include study limitations (risk of bias), consistency of results, directness of evidence, precision and publication bias. It is recommended that risk of bias is assessed on outcome level instead of trial level, because sources of bias can vary in importance across outcomes [15]. Since all of the studies included in our review had a high risk of bias on the trial level, consequentially risk of bias was likewise high on the level of each outcome. We therefore did not separately assess risk of bias for each outcome.

Data extraction and analysis

We independently extracted data on characteristics of the study population, intervention, study design and outcome measures by using a standardized data extraction form for randomized controlled trials. Where appropriate, data were entered into Review Manager 5 to calculate effect sizes and corresponding confidence intervals. We calculated between-group comparisons using change from baseline data (change scores) or final values, depending on which method was used in the primary study and conducted sensitivity analysis using the other method to test the robustness of the findings. However, these sensitivity analyses were not pre-planned. In some cases we had to calculate standard deviations (SD) from p-values. Where this was necessary we used the method described in the Cochrane Handbook [16]. To avoid the pitfall of applying parametric tests to non-parametric data, we did not enter data into RevMan if there was evidence of skew, as this software assumes a normal distribution. However, we would have reported the results of such trials descriptively in the text, provided that they were analyzed with appropriate non-parametric tests. We did not perform meta-analyses due to the heterogeneity of the included studies.

Results

Study selection

Figure 1 depicts a flow diagram illustrating the study selection process in accordance with the PRISMA statement [8]. We included one trial which was published three days after we conducted our electronic searches and of which we became aware shortly after its publication [17]. Altogether 4 trials remained eligible for inclusion after screening of search results: one trial with geriatric patients from Germany, one trial with adults with multiple sclerosis from Slovenia, one trial with children with special needs from Canada and one trial with adults with chronic low-back pain from Germany [5], [17], [18], [19]. One of the included trials was only published in German [5]. We were unable to retrieve one potentially relevant trial of people with snake phobia, which was only published as a dissertation [20]. No disagreements occurred regarding inclusion of studies.

Study characteristics

The main characteristics of the included studies are summarized in Table 1. The intervention in adults with chronic low-back pain was described as therapeutic climbing near the ground using a wall of 4 m width and 2.5 m height [17]. For safety reasons no more than two participants were allowed to use the wall simultaneously and gym mats were placed on the ground. Each training session included warm-up exercises of 10 to 15 min. and about 30 min. of climbing. Before the specific exercises

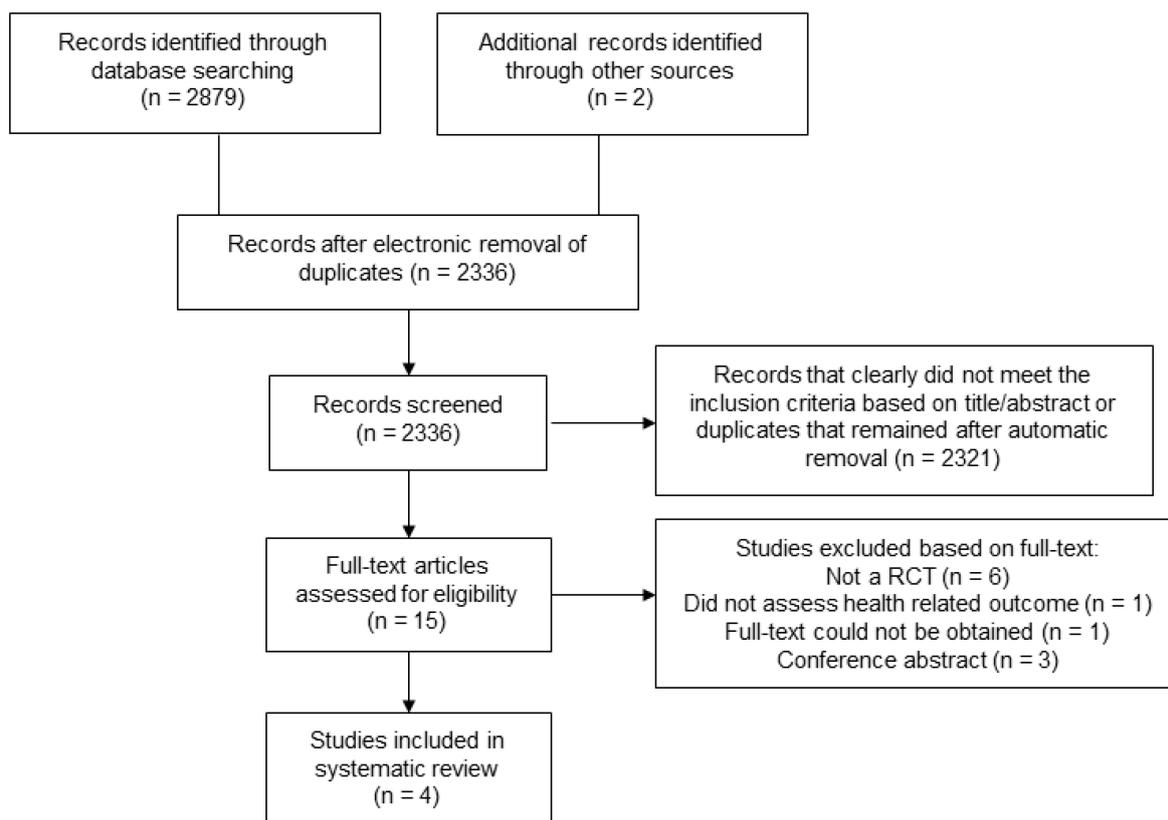


Figure 1: Selection of studies

the participants were instructed to traverse laterally along the wall using all the holds they needed. After this warm-up, participants performed specific exercises designed to train coordination, stabilization and trunk muscles. These exercises were not described in any more detail. Exercises were adapted to the individual participants to provide them with a feeling of success. The sessions ended with a fun exercise such as climbing blindfolded, traversing without use of a certain hold or collecting small items placed in holds. The control group intervention consisted of exercise with a bicycle or a fitness ball and exercises that aimed to improve stabilization and trunk muscles. These included strengthening exercises, stretching, mobilization, coordination and stabilization of the abdominal, back, pelvic and lower limb muscles. The sessions ended with cool-down or relaxation exercises of about 10 min. Both groups received a separate lesson on proper body mechanics for Activities of Daily Living (ADL) and were allowed to do sports in their spare time. The intervention in geriatric patients was described as therapeutic climbing near the ground using holds at least the size of wall bars [5]. To ensure patient safety the floor was covered with mats and participants were spotted by their therapists. Participants were warmed up using low intensity grip exercises. The control group received usual care physiotherapy including gait training and strengthening exercises. The authors did not provide any specific information on the exercises used. The sport climbing program in children with disabilities and poor motor function was held at a public indoor

climbing facility and involved 6 weekly sessions of one hour each [19]. Each child was supervised by one or two adults, depending on their level of disability as well as extra staff that moved around the gym to coach children and help them physically if they were experiencing difficulties climbing. The program aimed to create an environment that allowed all participants to be successful. The goals were (a) to teach children how to stay safe, calm and focused in a stimulating environment, (b) learning climbing skills (how to tie the rope into their harness, communicate with the belayer, how to move on the wall and how to descend safely), (c) learning social skills (how to interact with their peers and follow the guides' instructions). The children mainly climbed on the beginner wall, but were free to try more difficult climbs if they wanted. The intervention was compared to a waiting-list control group.

The sport climbing sessions in adults with multiple sclerosis took place in a training, occupation and care center and were held by two licensed instructors [20]. A five meter climbing wall with numerous large holds inclined to 90° was used. Patients were secured by a licensed climbing instructor with a top-rope system. Patients were asked to attend at least 9 out of 10 sessions. No further details on the climbing program were provided. The control group received 10 sessions of hatha yoga held by a specialist multiple sclerosis nurse, who was a yoga instructor licensed to train people with physical disabilities.

Table 1: Trial characteristics

| Study | Age | Female (%) | No randomized | No analysed | | Indication | Intervention | Control | Outcomes |
|---------------------|----------------------------|------------|---------------|--------------|---------|----------------------------------------------------|-------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------------------|
| | | | | Intervention | Control | | | | |
| Engbert 2011 [17] | Mean: 48.7 (SD: 9.7) | 52 | 28 | 10 | 13 | Chronic low-back pain | 4x45 min therapeutic climbing a week for 4 weeks | 4x45 min of regular exercise 4 times a week for 4 weeks | SF-36, FFbH-R |
| Fleissner 2010 [5] | Mean: 81 | 62 | 95 | N/A | N/A | Functional rehabilitation of geriatric patients | 5 weekly session of therapeutic climbing near the ground (30 min each) | Physiotherapy (usual care) | Number of falls, Timed Up & Go Test, Tinetti Test, Barthel-Index |
| Mazzoni 2009 [19] | Mean: 8.4 Range: 6–12 | 20 | 48 | 10 | 8 | Children with disabilities and poor motor function | 6 weekly sports climbing sessions in a public climbing facility (60 min each) | Wait-list | SPPC |
| Veilkonja 2010 [18] | Median: 42 Range: 26–50 | N/A | 20 | N/A | N/A | Adults with multiple sclerosis | 10 weekly sports climbing sessions (duration not stated) | Hatha yoga | MAS, EDSSpyr, MFI, CES-D |

Risk of bias of included studies

The sample sizes of the included studies ranged from 20 to 95. All trials had a high risk of bias with none fulfilling more than two of our quality criteria (Table 2). In particular, incomplete outcome data was not addressed in any of the trials. In the geriatric rehabilitation trial participants who were discharged before completion of all five therapeutic climbing sessions were excluded from the analysis, but numbers or reasons for exclusion were not provided [5]. In the trial with children with special needs two participants were excluded after randomization, because one did not have any means of transportation to the climbing facility and another could not cope with the climbing environment [19]. For the outcome relevant to this review, the Self-Perception Profile for Children (SPPC), more than 60% of the children initially randomized were excluded because they did not have a sufficient chronological age to complete the questionnaire. In the trial in adults with chronic low-back pain 5 out of 28 participants were excluded from the analysis because they did not attend at least 70% of the climbing sessions [17]. No information on drop-outs was provided in the trial in adults with multiple sclerosis [18]. Most of the trials did not provide a clear statement on primary and secondary outcomes and did not adjust for multiple comparisons. One disagreement occurred regarding the risk of bias assessment, which was resolved by discussion with a third person.

Findings of the review

In people with non-specific chronic low back pain a statistically significant effect of therapeutic climbing compared to standard exercise was found on physical functioning and general physical health measured by the SF-36 with mean differences (MD) in change scores of 16.15 [95% CI: 4.45 to 27.85] and 13.14 [95% CI: 3.61, 22.67], respectively [17]. Mean differences did not attain statistical significance in a sensitivity analysis using group comparisons based on final values. No significant effect was found on the Hannover functional ability questionnaire for measuring back-pain related disability (FFbH-R), based on change scores (MD: -0.42 [95% CI: -29.45 to 28.61]) or final values (MD: -11.75 [95% CI: -28.75 to 5.25]).

In functional geriatric rehabilitation therapeutic climbing had a significant effect on activities of daily living as measured by the Barthel index compared to physiotherapy (MD of change scores: 2.32 [95%-CI: 0.45 to 4.19] [5]. The effect was much larger in a sensitivity analysis using final values (MD: 9.01 [95% CI: 2.52, 15.50]). This difference, however, occurred mainly due to baseline imbalances between groups. A significant difference was also found for the timed up & go test and the Tinetti Test in favor of the climbing group with mean differences of change scores of -2.86 [95% CI: -4.51 to -1.21] and 1.53 [95% CI: 0.46 to 2.60], respectively. These effects were similar in a sensitivity analysis using final values.

Table 2: Risk of bias of included studies

| Study | Random sequence generation | Allocation concealment | Blinded outcome assessment | Incomplete outcome data | Risk of selective reporting | Risk of other biases | Description of other biases |
|----------------------|----------------------------|------------------------|----------------------------|-------------------------|-----------------------------|----------------------|--------------------------------------------------------------------------------------------------|
| Engert 2011 [17] | Low risk | Low risk | Unclear risk | High risk | Unclear risk | High risk | multiple comparisons, baseline imbalances |
| Fleissner 2010 [5] | Unclear risk | Unclear risk | Low risk | High risk | High risk | High risk | baseline imbalances, number of falls partially ascertained retrospectively, multiple comparisons |
| Mazzoni 2009 [19] | Unclear risk | Low risk | High risk | High risk | Unclear risk | High risk | multiple comparisons, analysis based on only a small proportion of patients |
| Veilikonja 2010 [18] | Unclear risk | Unclear risk | Low risk | Unclear risk | Unclear risk | High risk | baseline imbalances, poor statistical methods, multiple comparisons |

The authors reported that there was no significant difference in number of falls, but did not provide any data on this outcome.

There was no significant effect of sport climbing on competence of children with disabilities and poor motor function compared with waiting-list control as measured on different subscales of the Self-Perception Profile for Children with mean differences of 2.10 [95% CI: -1.79, 5.99] for athletic competence, -0.40 [95% CI: -3.85, 3.05] for general self-esteem and -1.20 [95% CI: -6.68, 4.28] for social-competence [19]. Findings were similar in an analysis using change scores. The trial in adults with multiple sclerosis only reported within group differences, thus essentially ignoring the group comparison [18]. Unfortunately we were not able to calculate effect sizes for this trial due to skewed data.

Discussion

Very low quality evidence suggests that therapeutic climbing may have a clinically meaningful effect on physical functioning and general physical health in adults with chronic low-back pain. The observed effects based on between-group change scores appear to exceed a minimal important difference suggesting a meaningful effect [21], [22]. However, the effect was not robust to sensitivity analysis using final values. Furthermore, very low quality evidence suggests that therapeutic climbing may have an effect on activities of daily living in geriatric patients. However, the confidence interval in our analysis using change scores includes a clinically insignificant effect. In a study with care home residents a 2 point change on the Barthel index has been suggested as a minimal important difference (MID) and a MID of 1.85 has been established in a small study with stroke patients [23], [24]. The clinical relevance of the statistically significant improvement in the timed up & go test is difficult to interpret due to lack of an established MID [25]. The same difficulty applies to the Tinetti Test, which also has been criticized for performing poorly in predicting falls [26]. Overall, the limited evidence regarding sport or therapeutic climbing in the prevention or treatment of health problems does not allow any arguments for or against its use.

Review limitations

Our review has some limitations. We attempted to find all randomized trials of therapeutic or sport climbing by searching several electronic databases. However, we were not able to validate our search strategy since only a small sample of trials was available. We were not able to retrieve the full text of at least one potentially eligible study, a dissertation in people with snake phobia [20]. This study only included 10 participants and we therefore do not believe that an important amount of evidence was omitted. Another limitation of our review is that we did not contact authors in order to provide further trial details.

There is evidence that authors often do not fully report the methodological details of their trials, which makes judging risk of bias difficult [27]. Given the small sample sizes of the included studies resulting in imprecise effect estimates as well as other study limitations, we do not believe that our conclusions would have changed if more information had been available.

We are concerned about selective outcome reporting in the included studies due to lack of availability of a study protocol and pre-specified primary outcomes and methods of analysis. In particular we were not able to rule out the possibility that the decision to report group comparisons based on final values or change scores was based on the statistical significance of the findings. For this reason we conducted sensitivity analyses using either method to test the robustness of the findings. However, these were not pre-specified in our protocol and therefore should be interpreted with caution.

Recommendations for future research

The quality of reporting of the trials included in our review was poor. Future trials should be reported in accordance with reporting guidelines in order to help readers understand trial design, conduct and analysis, and allow them to assess the validity of results [28]. Only one trial provided a detailed description of the intervention under study. In order to act upon the results of a trial and apply a non-pharmacologic treatment in practice or further research it is essential that readers be able to reproduce the intervention. Therefore the aim and components of the intervention(s) under study should be described in sufficient detail. Description of interventions should include information on the contents of the intervention, the setting where it took place and by whom it was delivered, how it was delivered, e.g. regarding its intensity, frequency and duration and how flexible the treatment protocol was [29]. It is also important for readers to be able to assess whether an intervention was delivered as planned – particularly if it was ineffective. This allows them to judge whether the intervention was ineffective in itself or possibly because of lack of study fidelity. Information on the implementation of the intervention can also be helpful to determine whether the intervention is feasible and can be applied to real-life settings [16].

Future trials should adopt strategies to ensure that the chosen outcomes will be relevant to patients. For example future studies with older people could include fear of falling, which can decrease quality of life, lead to less activity and hereby in turn increase the risk of falling due to functional decline [30], [31].

Conclusions

In conclusion, we did not find any convincing evidence for the effectiveness of therapeutic climbing or sport climbing to prevent or treat health problems. Future studies should have a sufficient sample size and use

patient important outcomes. They should be registered prospectively in order to prevent selective outcome reporting. Publications should be reported in accordance with the CONSORT statement to allow proper assessment and include detailed information on the interventions that are used.

List of abbreviations

CES-D: Center for Epidemiologic Studies Depression Scale
 EDSSpyr: Expanded Disability Status Scale pyramidal function score
 FFbH-R: Hannover functional ability questionnaire for measuring back-pain related disability
 MAS: Modified Ashworth Scale
 MD: Mean difference
 MFI: Modified Fatigue Impact Scale
 SD: Standard deviation
 SPPC: Self-Perception Profile for Children

Notes

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Competing interests

RB and DF work for an independent German evidence assessment agency that conducts health technology assessments and publishes consumer health information. RB is a sports climber. No financial support was received for this review.

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Corresponding author:

Roland Brian Buechter
 Institut für Qualität und Wirtschaftlichkeit im
 Gesundheitswesen (IQWiG), Dillenburger Strasse 27,
 51105 Köln, Germany
roland.buechter@iqwig.de

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