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Bouldering psychotherapy is not inferior to cognitive behavioural therapy in the group treatment of depression: A randomized controlled trial

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Objectives. Bouldering has shown promising results in the treatment of various health problems. In previous research, bouldering psychotherapy (BPT) was shown to be superior to a waitlist control group and to physical exercise with regard to reducing symptoms of depression. The primary aim of this study was to compare group BPT with group cognitive behavioural psychotherapy (CBT) to test the hypothesis that BPT would be equally as effective as CBT.

Design. We conducted a randomized, controlled, assessor-blinded non-inferiority trial in which 156 outpatients meeting the criteria of a depressive episode according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) were randomly assigned to one of the two intervention groups (CBT: $N = 77$, BPT: $N = 79$).

Methods. Intervention groups were manualized and treated for 10 weeks with a maximum of 11 participants and two therapists. The primary outcome was depressive symptom severity assessed with the Montgomery–Åsberg Depression Rating Scale (MADRS) and the Patient Health questionnaire (PHQ-9) at the beginning and end of the treatment phase as well as one year after the end of treatment.

Result. In both groups, depressive symptoms improved significantly by an average of one severity level, moving from moderate to mild depressive symptoms after therapy (MADRS difference scores: BPT −8.06, 95% CI [−10.85, −5.27], $p < .001$; CBT −5.99, 95% CI [−8.55, −3.44], $p < .001$). The non-inferiority of BPT in comparison with CBT was established on the basis of the lower bound of the 95% confidence interval falling above all of the predefined margins. BPT was found to be effective in both the short ($d = 0.89$) and long term ($d = 1.15$).

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Conclusion. Group BPT was found to be equally as effective as group CBT. Positive effects were maintained until at least 12 months after the end of therapy. Thus, BPT is a promising approach for broadening the therapeutic field of therapies for depression.

Practitioner points

- Physical activity is effective in the treatment of depression and current guidelines explicitly recommend it as a complementary method for the treatment of depression. Nevertheless, body-related interventions are still underrepresented in current treatments for depression.
- Bouldering psychotherapy (BPT) combines physical activity with psychotherapeutic content. Its concept relies on proven effective factors from CBT such as exposure training, problem solving and practicing new functional behaviours and is thus an enrichment and implementation of CBT methods on the bouldering wall.
- The positive effect of group bouldering psychotherapy (BPT) in reducing depressive symptoms in outpatients with depression is not inferior to the effect of group cognitive behavioural therapy (CBT).
- Additionally the 10-weeks BPT-programme significantly improved symptoms of anxiety and interpersonal sensitivity as well as health-related quality of life, coping, body image, self-efficacy, and global self-esteem.

It has been known for a long time that body-related interventions can have strong effects on mental states (Barnard & Teasdale, 1991). In recent studies, physical activity has been shown to be effective in the treatment of depression in general (Gordon et al., 2018; Schuch et al., 2016) and particularly when it is used to augment the effects of psychotherapy (Bourbeau, Moriarty, Ayanniyi, & Zuhl, 2020; NICE, 2009). Physical activity is even explicitly recommended in the current guidelines as a method that can complement the treatment of depression (DGPPN, 2015; NICE, 2009). Such a combination might be especially effective because it encompasses both psychological effects (i.e., cognitive effects, improved self-efficacy, improved mood states) and physiological effects (neurophysiological effects, i.e., structural changes and increases in the sizes of certain brain regions and hormonal effects, i.e., changes in stress hormones; Bourbeau et al., 2020; Cooney et al., 2013). Nevertheless, body-related interventions are still underrepresented in current treatments for depression (e.g., CBT).

One special form of physical activity that has become increasingly popular in recent years is bouldering (Lutter, El-Sheikh, Schoffl, & Schoffl, 2017). Bouldering is defined as climbing to moderate heights without the use of ropes or harnesses. Recent studies have indicated that climbing and bouldering have specific positive effects on psychological factors, such as cognitive abilities (Schnitzler, 2009; Wallner, 2010), self-confidence, self-esteem, self-efficacy (Mazzoni, Purves, Southward, Rhodes, & Temple, 2009; Wallner, 2010), social skills (Schnitzler, 2009; Wallner, 2010), quality of life (Kim & Seo, 2015), anxiety (Wallner, 2010), and mood (Lukowski, 2017; Luttenberger et al., 2015). Systematic reviews have confirmed that therapeutic climbing may have positive effects on health problems (Buechter & Fechtelpeter, 2011; Fruhauf, Sevecke, & Kopp, 2019) but have also highlighted the need for future high-quality studies, as many of the existing studies have suffered from methodological problems.

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Thus, we developed a new form of group therapy for the treatment of depression called bouldering psychotherapy (BPT) because it combines the physical activity of bouldering with psychotherapeutic content that is targeted towards the treatment of depression. The psychotherapeutic techniques of BPT emerged from CBT, whereby BPT is targeted towards implementing effective learning and action factors (Lambert & Ogles, 2004; e.g., enhancing self-efficacy, problem solving, exposure training), and participants are encouraged to practice as much as possible in the session itself. Specific bouldering exercises are designed to trigger the patients' dysfunctional problem-solving patterns, and with that, their symptoms. This is possible because the atmosphere of bouldering is highly emotionally activating in and of itself, and interactions with other group members during partner or group exercises make interpersonal problems immediately visible. A patient's dysfunctional behaviour or thinking can be analysed with the help of the therapist and the group, which supports the patient and acts as a model for corrective experiences. Then alternatives can be re-practiced in the same bouldering exercise, and the new experience can be transferred to everyday problems. Beginners in particular make athletic progress very quickly by learning bouldering techniques so that self-efficacy can easily be promoted. Furthermore, building positive activities is an essential part of psychotherapy for depressive disorders, and bouldering itself can be such a positive activity for patients because of its highly motivating atmosphere, thus counteracting any loss of interest (Hautzinger, 2011).

Compared with other pure psychotherapeutic methods that are effective for treating depression, BPT may have several other advantages. In addition to the positive effects of physical activity on the psychological factors listed above, these advantages also include physical side effects of sports interventions, such as reducing the risk of cardiovascular diseases (Mermier, Robergs, McMinn, & Heyward, 1997; Rodio, Fattorini, Rosponi, Quattrini, & Marchetti, 2008). Another significant advantage of BPT is the low stigma of bouldering. Patients are likely to be less reluctant to participate in a (psychotherapeutic) sports group than in classical group (or individual) psychotherapy (Mojtabai et al., 2011). Additionally, in its role as a positive activity, bouldering can be continued after the end of the treatment, and patients can have the opportunity to tie their new bouldering experiences in with their experiences from therapy.

In our pilot study, we found that BPT was effective in reducing depressive symptoms compared with a waitlist control group, even when physical activity was controlled for (Luttenberger et al., 2015; Stelzer et al., 2018). Long-term outcomes 10 months after the end of treatment were also promising (Schwarz et al., 2019). The aim of this study was to investigate the effect of our BPT group intervention by using a randomized controlled design and comparing BPT with established group treatment options (see Dorscht et al., 2019). In this paper, we compared BPT with CBT as the current non-pharmacological gold standard in the treatment of depression. We included secondary outcomes that were based on either the literature (i.e., self-efficacy, self-esteem, social skills, anxiety, quality of life) or on theory (i.e., body image, coping abilities). We hypothesized that the positive effects found in group BPT in reducing depressive symptoms in outpatients with depression would not be inferior to the effects found in group CBT.

Methods

Study design

We conducted a randomized, controlled, assessor-blinded, non-inferiority trial (NI) with three groups – a BPT group, a CBT group, and an active control group (home-based

exercise programme, EP) – in three study centres throughout Germany. The study was conducted in consecutive waves in each study region, with all of the three treatments taking place in each wave and during the same time period in each study centre. We had two main hypotheses with different methodologies: a superiority hypothesis comparing BPT with the EP as well as a NI hypothesis comparing BPT with CBT. The complete trial is described in detail in the study protocol (Dorscht et al., 2019). A comparison of the BPT group with the EP group was previously conducted in a study that demonstrated the superiority of BPT (Karg, Dorscht, Kornhuber, & Luttenberger, 2020). In this paper, we focussed on the hypothesis that BPT is not inferior to CBT. Therefore, only the BPT and CBT treatments are presented. All study procedures were approved by the Ethics Committee of the Friedrich-Alexander University Erlangen-Nürnberg (FAU). Consent was obtained in written form.

Study registration

The study was registered (partly retrospectively) on 26 July 2017 with the trial identification number ISRCTN12457760. The recruitment period ran from March 2017 to March 2018. Patient enrolment overlapped briefly with the registration process for organizational reasons. We confirm that the study was conducted as described in the study registration. Related clinical trials have been registered (ISRCTN17623318; Luttenberger et al., 2015). Future clinical trials will be registered prospectively.

Participants

Recruitment

Participants were recruited through press releases in local newspapers and radio announcements as well as by distributing informational material (e.g., flyers, posters, brochures) in the three study locations at psychiatric hospitals, locally based psychotherapists' or psychiatrists' offices, primary care physicians' offices, pharmacies, and other psychological services (e.g., support groups). Additionally, we set up a homepage (www.studieKuS.de) and a Facebook account. People who were interested in the study were invited to group-based information events in which we introduced potential participants to the study's aims, procedures, and conditions for participation.

Inclusion and exclusion criteria

Inclusion criteria were a PHQ-9 score of at least 8 (Gräfe, Zipfel, Herzog, & Löwe, 2004), written informed consent to participate in the study, and the ability to reach the therapy locations. Exclusion criteria were age younger than 18 years, a Body Mass Index (BMI) under 17.5 or over 40, concurrent participation in another psychotherapeutic group therapy, initiated psychiatric medication in the last eight weeks, initiated individual psychotherapy in the last eight weeks, intended inpatient stay during the intervention period, physical contraindication for bouldering, psychosis within the last five years, a manic episode within the last five years, substance addiction with substance abuse within the last year, a diagnosis of borderline personality disorder with self-harming behaviour during the last year, and acute suicidality. Before recruitment began, minor modifications were made to the inclusion criteria compared with the study protocol: The upper limit of BMI was increased from 35 to 40, and the cut-off for the PHQ was reduced to 8, thus

ensuring a high level of sensitivity to all depressive disorders (Gräfe et al., 2004; see also ISRCTN12457760). The inclusion and exclusion criteria were assessed via self-report in the first step and verified via personal interviews by members of the study's headquarters if there were any uncertainties (i.e., regarding the fulfilment of the diagnostic criteria, regarding relevant psychiatric diagnoses, or when patients indicated a potential risk of suicidality).

Data collection

Data were collected via computer-assisted telephone interviews before the intervention began (pre-test), at the end of the 10-week intervention period (post-test), and 12 months (follow-up) after the intervention was completed. The interviewers were psychology students trained at the study's headquarters and constantly supervised by two psychotherapists at the headquarters. To determine consistency among raters, 10 (4%) of the pre-test and 11 (5%) of the post-test interviews that were based on the structured interview guide for the Montgomery-Åsberg Depression Rating Scale (SIGMA; operationalization of the primary outcome MADRS) were conducted under the supervision of a second person who also rated the interviewees' answers on the SIGMA. An inter-rater reliability analysis using intraclass correlations (ICCs) was also performed across all groups afterwards.

Interventions

Each of the two therapy group treatments lasted 10 weeks with weekly meetings of 120 min. Groups consisted of a maximum of 11 participants. BPT and CBT took place in either a bouldering gym (BPT) or a room in the hospital used for group therapy (CBT) in the late afternoon. We had teams of two therapists for each intervention in each study region who were thoroughly trained for a whole day to implement BPT or CBT in accordance with the respective manuals by two members of the study's headquarters. All in all, we had nine climbing therapists for the BPT groups (between the ages of 26 and 38; 8 were women) and eight therapists for the CBT groups (between the ages of 26 and 44; 5 were women). All but one (a bouldering therapist) were either licensed psychotherapists for CBT (4 in the CBT group and 3 in the BPT group) or in the process of completing the advanced stages of their psychotherapeutic training hours (4 in the CBT group and 5 in the BPT group). The one exception had an MSc in Health Science including sports psychology. The climbing therapists were experienced in bouldering and rock climbing and were thoroughly trained in bouldering techniques, safety rules, and didactic elements by a professional bouldering instructor before they administered the therapy. For BPT and CBT, we developed detailed manuals that include a fixed schedule for each of the 10 sessions. Every session focussed on a specific psychological topic that we considered to be relevant in the development and maintenance of depression and followed a fixed sequence that included an introduction phase, an action phase, and a closure phase.

For BPT, the sessions began with a mindfulness exercise, followed by the presentation of and a brief exchange about the topic of the session (introduction phase). Afterwards, one to two subject-related bouldering exercises were conducted (action phase). These were supposed to evoke underlying emotions (e.g., anxiety), unveil patients' characteristic patterns (e.g., avoidance), and – with the therapists' support – enable patients to engage in new experiences (e.g., exposition: bouldering blindfolded). If any time was left,

free bouldering was enabled. The sessions ended with a discussion of experiences during the bouldering exercises and a body-related relaxation exercise (closure phase).

The CBT treatment was based on manuals on CBT for treating depression and combined the psychoeducational parts of Schaub, Roth, and Goldmann (2013) with specific exercises as well as elements of strategic behavioural therapy (SBT) by Sulz (2011) and elements of the short-term concept by Hautzinger and Kischkel (1999). Each session began with a mindfulness exercise, followed by a brief interactive repetition of the last session, and a review of the home-based exercises (introduction phase). Afterwards, the specific topic was developed interactively using flipcharts, exercise sheets, and experiential exercises such as role-plays and small-group work (action phase) as described in the respective manual. At the end, worksheets were handed out, home-based exercises were discussed, and a relaxation exercise (progressive muscle relaxation according to Jacobsen; Bernstein & Borkovec, 2007) was carried out (closure phase).

Table 1 presents an overview of the therapy sessions for BPT and CBT. For a more detailed description, see our study protocol (Dorscht et al., 2019).

We developed standardized adherence rating scales for the therapists to complete after each session (e.g., to report deviations from the manual, adverse events, and other extraordinary events). Supervision was offered via telephone by a CBT therapist and the BPT therapist who developed the manual. As such, the therapists in each group were contacted at least twice per round (immediately after the first or second session and at the end of each round). The staff at the study's headquarters could be contacted anytime during the entire study period for questions or to eliminate uncertainties.

Outcomes

Primary outcome

The primary outcome was depressive symptom severity. It was assessed with a semi-structured clinician-rated interview, which was based on the Montgomery-Åsberg Depression Rating Scale (MADRS; Montgomery & Asberg, 1979), the structured interview guide for the Montgomery-Åsberg Depression Rating Scale (SIGMA; Williams & Kobak, 2008). The MADRS consists of 10 items that are rated on a 7-point scale ranging from zero to six with higher scores indicating greater severity of symptoms. A score greater than 31 on the MADRS indicates severe depression, whereas a score of 10 or below indicates remission (Hawley, Gale, Sivakumaran, & group, 2002; Müller, Himmerich, Kienzle, & Szegedi, 2003).

Additionally, we used a self-assessment tool, the 9-item Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001; Löwe, Spitzer, Zipfel, & Herzog, 2002). The nine items are rated on a 4-point scale ranging from zero to three. Scores ranging from 0 to 4 indicate minimal depression, 5 to 9 mild depression, 10 to 14 moderate depression, 15 to 19 moderately severe depression, and 20 to 27 severe depression (Gräfe et al., 2004; Kroenke et al., 2001). In our study, a cut-off of at least 8 points was used to operationalize the presence of depression, thus ensuring a high level of sensitivity to all depressive disorders (Gräfe et al., 2004).

Secondary outcome

Secondary outcome measures include health-related quality of life as assessed with a visual analogue scale from the EuroQol Five Dimension Questionnaire (EQ-5D; Group, 1990),

Table 1. Overview of the therapy sessions (BPT and CBT)

Session	BPT	CBT
1	Introduction to bouldering and mindfulness	Introduction to CBT and mindfulness
2	Physical feeling and the body's centre of gravity	Psychoeducation on depression and dysfunctional beliefs
3	Healthy handling of limitations	Identifying and working on individual dysfunctional beliefs
4	Expectations and standards	Behavioural activation/activity scheduling
5	Self-efficacy, achievements, and pride	Social relationships I: self-confidence, role plays
6	Self-esteem	Social relationships II: healthy handling of limitations and duties, role plays
7	Fear and trust I	Cognitive techniques I: dysfunctional beliefs regarding achievements and pride
8	Fear and trust II	Cognitive techniques II: ABC scheme
9	Social relationships	Lessons learned: Transforming dysfunctional beliefs
10	Problem solving, reflecting on lessons learned and on transferring them to daily life	Reflecting on lessons learned and on transferring them to daily life

Note. BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy.

health-related resources and manageability as assessed with the Questionnaire on Resources and Self-Management Skills (FERUS; Jack, 2007), body image disturbances and subjective aspects of body experiences as assessed with the Body Image Questionnaire (FKB-20; Clement & Lowe, 1996), anxiety as assessed with the Generalized Anxiety Disorder 7 (GAD-7; Löwe et al., 2002; Spitzer, Kroenke, Williams, & Lowe, 2006), self-efficacy as assessed with the General Self-Efficacy Scale (GSE; Romppel et al., 2013), self-esteem as assessed with the Rosenberg Self-Esteem Scale (R-SES; Collani & Herzberg, 2003), and interpersonal sensitivity as assessed with the subscale from the Symptom Checklist-90 (SCL-90; Franke, 2002). Attitude towards group allocation (EP, CBT, BPT) was recorded in the screening questionnaire for a sub-sample using a 5-point scale ranging from very unpleasant to very pleasant. Adverse events (AEs), such as strains, ligament ruptures, or fractures, as well as severe adverse events (SAEs), such as suicidal attempts or actual suicides, were documented by the therapists who handled each group during the intervention period. Interim analyses of (S)AEs were performed on a regular basis so that the BPT treatment could be terminated if significantly more AEs or SAEs occurred in the BPT group than in the CBT group. All measures are described in detail in our study protocol (Dorscht et al., 2019).

Randomization and masking

All individuals meeting the inclusion criteria in one study region and one wave were randomized into one of the three groups (BPT, CBT, EP). Randomization was performed externally by the Institute of Medical Informatics, Biometry, and Epidemiology (IMBE) of the Friedrich-Alexander University Erlangen-Nuremberg, with whom we shared only the screening date, participant code, sex, and severity of depression (categorized via PHQ-9 scores from screening: 8–14 mild to moderate, 15–19 moderately severe, 20–27 severe). Random allocation to the three groups (BPT, CBT, EP) was stratified by study centre and was performed blockwise by study wave, using a minimization algorithm to dynamically balance groups with respect to sex and severity of disease. After randomization, participants were informed about their allocation and provided with all necessary information about group participation. Interviewers who assessed the outcomes of the study were blind to participants' allocations. Prior to each interview, all participants were reminded of the confidential nature of their allocation and asked not to tell the interviewer which treatment they had received. After the interview at the end of the intervention period, former CBT and EP participants who wished to take part in a BPT group were allowed to do so. We offered this option to the participants with the hope of keeping the dropout rate in the follow-up interviews as low as possible.

Statistical analysis

Definition of the equivalence margin

In NI trials, changes in the dependent variable during treatment with the new intervention (BPT) are considered non-inferior to changes in the dependent variable during treatment with an established intervention (CBT) if the confidence interval (CI) for changes in the dependent variable from the new intervention does not exceed the lower bound of the equivalence margin. The so-called equivalence margin has to be prospectively defined (Hahn, 2012) and should reflect the 'smallest evidence of inferiority, that if true, would mean the new treatment is unacceptable' (Macaya, Ryan, Salinas, & Pocock, 2017, p. 895).

Besides specifying the equivalence margin on the basis of clinical significance, which is recommended by the European Medicines Agency (Committee for Medicinal Products for Human Use, 2005), two approaches have been suggested: The margin could be the whole or part of the established treatment effect versus a placebo effect from historical trials, or it could be defined by the treatment effect of the established treatment from this study versus the study's own placebo/control group (which would be the treatment effect of CBT vs. EP in our study). In its guidelines on 'The choice of the non-inferiority margin' (Committee for Medicinal Products for Human Use, 2005), the Committee for Medicinal Products for Human Use (CHMP) recommends that the choice of margin be based primarily on aspects of clinical relevance.

As stated in our study protocol (Dorscht et al., 2019), we defined the different margins in both ways. As a margin defined by clinical relevance, we used the difference between the CBT group and the active control group as an equivalence margin. We predefined a border of clinical relevance that the margin established by the direct comparison between CBT and the active control group should not exceed, which was five points (half a severity grade; Dorscht et al., 2019). The resulting equivalence margin was 3.0 MADRS points (see Results). This margin was used at post-test and follow-up. Additional literature-based margins were the following: For the PHQ-9, we used a predefined margin of 1.9 points, which is well-established in the literature (Richards et al., 2016). For the MADRS, we predefined two margins (Cohen's *d* values of 0.2 and 0.34) on the basis of effect sizes that were found in previous research in which CBT was compared with a placebo (Feng et al., 2012; Okumura & Ichikura, 2014). These literature-based margins were established for data collected directly after the end of therapy and were therefore used only for the comparison at post-test.

Sample size estimation

We estimated the sample size using the well-established margin of 1.9 PHQ points with a standard deviation (*SD*) of 3.8, an alpha of .05, and a power of 90%. The power analysis indicated that 69 patients were needed in each group (CBT and BPT).

The sample size for the intention to treat (ITT) analyses was large enough to perform the NI analyses with the abovementioned conditions. For the per protocol (PP) analyses, we missed the targeted number of patients by 5 (BPT) and 4 (CBT) people. The main reason was recruiting difficulties in the very rural area of one of the study locations. This problem occurred primarily at the beginning of the study before we had access to the local disseminators. The final *n* of 129 instead of 138 provided a power of 89% (PHQ-9) and 84% (MADRS; calculated with powerandsamplesize.com), levels that are commonly considered sufficient (Cohen, 1988; Rohrig, du Prel, Wachtlin, Kwiecien, & Blettner, 2010).

Data analysis

A missing data analysis was carried out, and missing values were imputed using the Expectation Maximum (EM) algorithm with the variables that explained the largest proportions of variance in the missing variable (Ali & Siddiqui, 2000). Data were imputed for 16 patients (10.3% of the ITT sample for BPT and CBT) who were not available for the assessment at post-test and for 33 patients (21.2% of the ITT sample for BPT and CBT) at follow-up. The data analyses were computed with the 'IBM SPSS Statistics 24' software.

For the main outcome, we report descriptive values before (pre-test) and after treatment (post-test) as well as 12 months after the end of treatment (follow-up). After

checking for sphericity, homogeneity of the error variances, and homogeneity of the covariances, a mixed-model ANOVA with one between-group factor and one repeated-measures factor was used to determine whether there was a Time × Group interaction. We expected no interaction and no main effect of group to occur. After confirming our expectations, to check for improvements within the groups (main effect of time), we calculated two separate repeated measures ANOVAs for the BPT and CBT groups. Afterwards, we calculated Bonferroni-adjusted *post-hoc* tests. The Greenhouse–Geisser adjustment was used to correct for violations of sphericity in the repeated measures ANOVA for MADRS in the ITT BPT sample.

For secondary outcomes, pre-test and post-test values are reported. After checking for homogeneity of variance, the change scores from the two groups were compared using *t*-tests for independent groups to see if group differences could be found. A Type I error (alpha) of less than 5% was considered indicative of statistical significance.

We accepted the NI of BPT in comparison with CBT if the lower bound of the two-sided 95% confidence interval (CI) of the difference between treatment changes in BPT versus CBT was above the lower bound of the margin. The primary data analytic strategy regarding the NI analysis is ITT (Macaya et al., 2017). As a sensitivity analysis, additional analyses with PP data were computed. The PP population was defined as participants who attended at least five out of 10 treatment sessions (50%). To control for additional offers of psychotherapy between post-test and follow-up (i.e., CBT, BPT, other group therapy, or individual psychotherapy), we performed a hierarchical regression analysis with the follow-up value as the dependent variable and the pre-test value, group allocation, and additional offers of therapy after post-test as predictors.

Results

Descriptive outcomes

Between March 2017 and March 2018, a total of 332 interested individuals were recruited, of which 233 met the eligibility criteria and were included as participants in the study (ITT sample). We randomly allocated 79 to the BPT group, 77 to the CBT group, and 77 to the EP group. According to our PP criteria of a 50% attendance rate in the treatment sessions, 198 participants were included in the PP analysis, of which 64 completed the BPT treatment, 65 completed the CBT treatment, and 69 completed the EP (Figure 1). The main reasons for dropout were insufficient participation, physical complaints that prevented those affected from participating any further (e.g., arm injury while cycling, mainly in the BPT group), as well as inpatient stays. Dropout rates did not differ significantly between the CBT and BPT groups (χ^2 test, $p = .574$). Before randomization, the participants rated an admission to the BPT group as well as to the CBT group as predominantly positive, but the percentage of those who rated BPT group participation as pleasant or very pleasant was significantly higher than for the CBT group (84.7% vs. 47.9%). Admission to the CBT group was rated as neutral by 33% in comparison with 12.5% for the BPT group.

On average, participants attended seven BPT (*SD* 2.4) or eight (*SD* 2.8) CBT sessions. Of the initial CBT participants, 20 people (26%) took part in BPT over the course of the year after their initial CBT. While administering BPT to 99 patients (79 in the regular BPT and 20 former CBT participants) with an average of seven therapy sessions per patient (1,386 bouldering hours in total), no adverse events occurred as a result of the therapy. Inpatient stays during the intervention period were equally distributed between the CBT and BPT groups. Baseline characteristics are presented in Table 2.

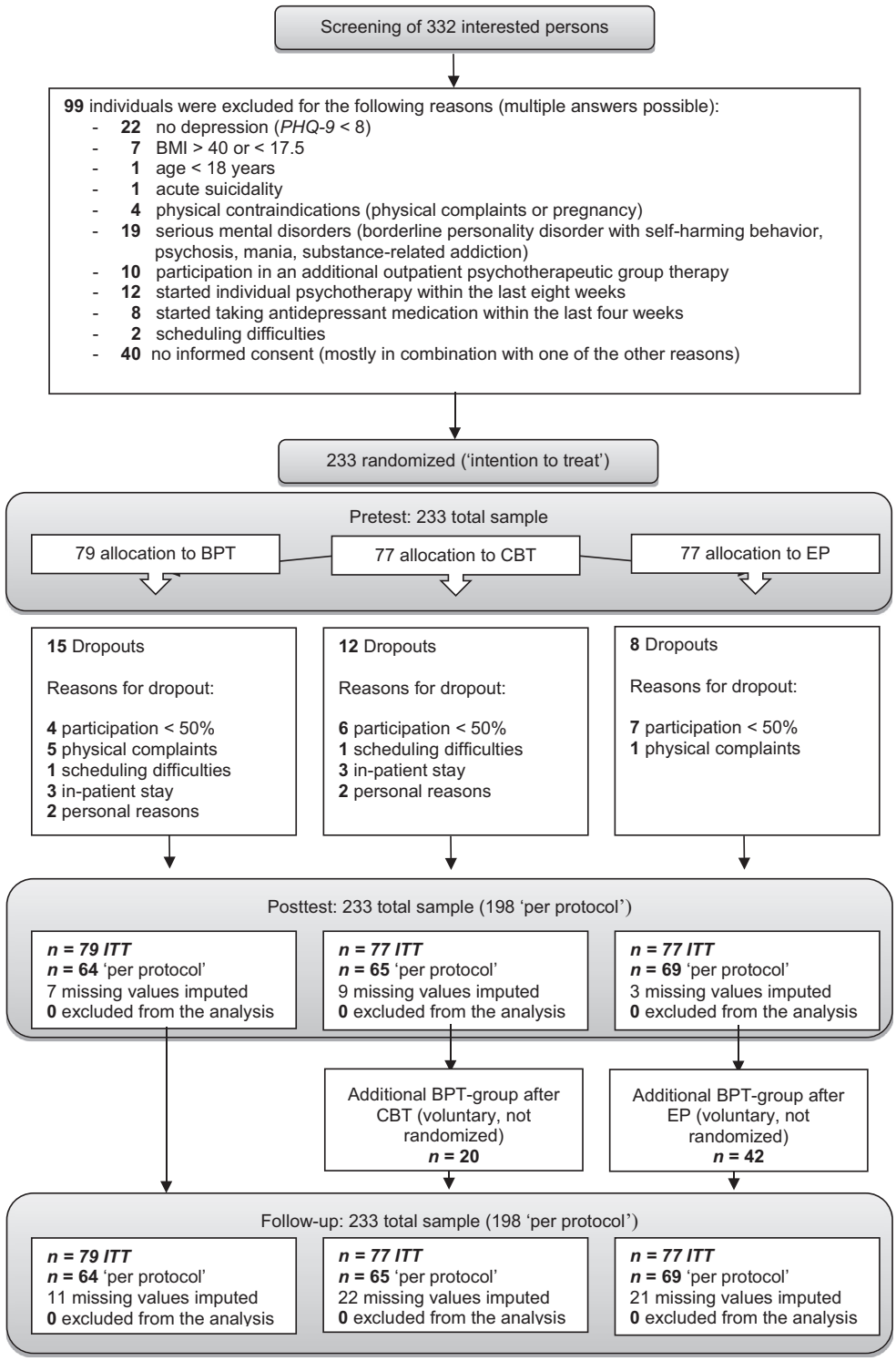

Figure 1. Consort flow chart. BMI = Body Mass Index; BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; EP = home-based exercise programme; ITT = intention to treat; PHQ-9 = Patient Health Questionnaire 9 Items.

Table 2. Baseline characteristics (ITT)

Variable	BPT (n = 79)	CBT (n = 77)	Total (N = 156)	Test of group differences		
				χ^2	t	p
Age, *M* (*SD*)	41.76 (12.6)	40.3 (11.4)	41.01 (12.01)		.79	.433
Sex, *n* (%)				0.08		.778
Female	54 (68.4)	51 (66.2)	105 (67.3)			
Male	25 (31.6)	26 (33.8)	51 (32.7)			
BMI, *M* (*SD*)	23.92 (3.37)	24.57 (4.17)	24.24 (3.79)		−1.07	.286
Family status, *n* (%)				1.49		.475
Single	40 (50.6)	43 (55.8)	83 (53.2)			
Married/living in a partnership	23 (29.1)	24 (31.2)	47 (30.1)			
Separated/divorced/widowed	16 (20.3)	10 (13.0)	26 (16.7)			
School education, *n* (%)				0.01		.994
<9 years	0 (0.0)	0 (0.0)	0 (0.0)			
9 years	9 (11.4)	9 (11.7)	18 (11.5)			
10 years	18 (22.8)	17 (22.1)	35 (22.4)			
>10 years	52 (65.8)	51 (66.2)	103 (66.0)			
Current occupation: yes, *n* (%)	50 (63.3)	45 (58.4)	95 (60.9)	0.39		.535
Additional psychotherapy: yes, *n* (%)	46 (58.2)	39 (50.6)	85 (54.5)	0.90		.342
Antidepressants: yes, *n* (%)	46 (58.2)	41 (53.2)	87 (55.8)	0.39		.531
Completed therapy in the past: yes, *n* (%)	59 (74,7)	52 (67,5)	111 (71,1)	0.75		.347
Attitude towards sports: positive, *n* (%)	75 (94.9)	75 (97.4)	150 (96.2)			.681[b]
First depressive episode: yes, *n* (%)	19 (24.1)	19 (24.7)	38 (24.4)	0.01		.928
Number of depressive episodes[a], *n* (%)				0.23		.972
1–2	23 (29.2)	19 (24.7)	42 (27.0)			

Continued

Table 2. (*Continued*)

Variable	BPT (n = 79)	CBT (n = 77)	Total (N = 156)	Test of group differences		
				χ^2	t	p
3–4	18 (22.8)	22 (28.6)	40 (25.7)			
5–10	8 (10.2)	10 (13.0)	18 (11.4)			
>10 or chronic depression (>2 years)	4 (5.2)	2 (2.6)	6 (3.8)			
Comorbidities, *n* (%)				3.11		.211
0	47 (59.5)	52 (67.5)	99 (63.5)			
1	20 (25.3)	20 (26.0)	40 (25.6)			
2–5	12 (15.2)	5 (6.5)	17 (10.9)			
Study region, *n* (%)				2.56		.279
Erlangen/Nuremberg region	39 (49.4)	37 (48.1)	76 (48.7)			
Weyarn region	20 (25.3)	27 (35.1)	47 (30.1)			
Berlin region	20 (25.3)	13 (16.9)	33 (21.2)			

Note. BMI = body mass index; BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; ITT = intention to treat.
[a]n = 106 (50 missing values); [b]Exact Fischer test because expected cell frequencies were below 5.

No significant group differences were found between the BPT group and the CBT group in their baseline scores on the psychometric measures, sociodemographics, or other potential confounds, such as age, gender, BMI, medication with antidepressants, current psychotherapeutic treatment, or attitude towards physical activity (see Table 2). The inter-rater reliability for the main outcome, the MADRS assessed with the SIGMA, was found to be excellent (ICC = .985, 95% CI [0.963, 0.994], $p < .001$). Between post-test and follow-up, patients were free to participate in any other therapies they were offered. In the CBT group, 50 of 77 participated in either a group therapy (including 20 who participated in at least one BPT session) or individual therapy. In the BPT group, 47 of 79 did so, most of whom received CBT ($p = .48$).

Calculation of the MADRS margin related to the study's own control group

The MADRS scores in the EP group (ITT) dropped from 22.27 (*SD* 9.12) to 19.27 (*SD* 10.97) points ($p = .004$). In the EP group, the mean difference in the MADRS scores between the end and beginning of the intervention period was −3.00 (*SD* 8.97) points. The between-group difference for the change scores from the EP and CBT groups was 2.99 (95% CI [0.10, 5.88]) points. The margin resulting from our own study was therefore 3 MADRS points, which is smaller than the predefined maximum of 5 MADRS points, defined by preliminary considerations of clinical relevance.

Main outcome

The depression-related outcomes (BPT and CBT) at pre-test, post-test, and follow-up are presented in Table 3 and Figure 2. During the intervention period (post-test – pre-test), depression scores on the MADRS dropped −8.06 points (95% CI [−10.85, −5.27]) in the BPT group ($p < .001$) and −5.99 points (95% CI [−8.55, −3.44]) in the CBT group ($p < .001$). From pre-test to follow-up, depression values dropped −9.95 points (95% CI [−12.83, −7.08]) in the BPT group ($p < .001$) and −9.28 points (95% CI [−12.10, −6.46]) in the CBT group ($p < .001$). For the PHQ-9, depression scores dropped −4.63 points (95% CI [−6.31, −2.94]) from pre-test to post-test in the BPT group ($p < .001$) and −3.46 points (95% CI [−5.04, −1.88]) in the CBT group ($p < .001$). From pre-test to follow-up, PHQ-9 scores dropped −5.56 points (95% CI [−7.21, −3.92]) in the BPT group ($p < .001$) and −4.82 points (95% CI [−6.34, −3.31]) in the CBT group ($p < .001$). In neither of the mixed-model ANOVAs was a significant Time × Group interaction or a main effect of group found, whereas time had a main effect in all mixed-model ANOVAs.

Non-inferiority at post-test

The between-group difference between the BPT and CBT groups of 2.07 MADRS points with a 95% CI of −1.00 to 5.12 had a lower bound that fell above the lower bound of the margin of −3.0 MADRS points defined by clinical relevance (see above); hence, NI was accepted (Figure 3).

The mean difference between the BPT and CBT groups for the MADRS scores (BPT −8.06 [*SD* 10.15] points, CBT −5.99 [*SD* 9.17] points) was 2.07 (*SEM* 1.55) points, which corresponds to a Cohen's *d* of 0.21 with a 95% CI of −0.10 to 0.53. Thus, the lower bound of the 95% CI fell above the lower bound of both of the predefined margins of $d = -0.2$ and $d = -0.34$ (Figure 4).

Table 3. Depression-related outcomes at pre-test, post-test, and follow-up

	M (*SD*)				Within-group difference Δ*M* (*SD*)[a]		Within-group effect size *d* (95% CI)[b]		Between-group difference, CBT-BPT, *M* (95% CI)		Between-group effect size, *d* (95% CI)[b,c]	
	Group	Pre-test	Post-test	Follow-up	Post – Pre	Follow-up – Pre	Post – Pre	Follow-up - Pre	Post – Pre	Follow-up –Pre	Post-test	Follow-up
Intention to treat (BPT *n* = 79, CBT *n* = 77)												
MADRS	BPT	23.46 (8.93)	15.40 (9.10)	13.50 (8.38)	−8.06 (10.15)***	−9.95 (10.45)***	0.89 (0.43–1.36)	1.15 (0.67–1.63)	2.07	0.67	0.21	0.07
	CBT	24.04 (7.69)	18.05 (10.36)	14.76 (8.00)	−5.99 (9.17)***	−9.28 (10.10)***	0.66 (0.20–1.12)	1.18 (0.70–1.67)	(−1.00 to 5.12)	(−2.58 to 3.92)	(−0.10 to 0.53)	(−0.25 to 0.38)
PHQ-9	BPT	13.66 (5.49)	9.03 (5.46)	8.09 (4.62)	−4.63 (6.13)***	−5.56 (5.99)***	0.85 (0.39–1.31)	1.10 (0.63–1.57)	1.17	0.74	0.20	0.13
	CBT	13.81 (4.65)	10.35 (6.00)	8.98 (4.63)	−3.46 (5.67)***	−4.82 (5.45)***	0.65 (0.19–1.10)	1.04 (0.57–1.52)	(−0.70 to 3.03)	(−1.07 to 2.55)	(−0.12 to 0.51)	(−0.19 to 0.44)
Per protocol (BPT *n* = 64, CBT *n* = 65)												
MADRS	BPT	23.47 (8.92)	15.10 (9.51)	13.61 (8.76)	−8.39 (10.41)***	−9.86 (10.76)***	0,81 (0,47–1,19)	1.12 (0.59–1.64)	2.36	1.23	0.24	0.12
	CBT	23.29 (7.30)	17.26 (10.25)	14.67 (8.64)	−6.03 (9.18)***	−8.63 (10.33)***	0.67 (0,46–1,18)	1.08 (0.56–1.60)	(−1.06 to 5.78)	(−2.44 to 4.91)	(−0.11 to 0.59)	(−0.23 to 0.46)
PHQ-9	BPT	13.52 (5.47)	8.86 (5.61)	8.11 (4.71)	−4.66 (6.25)***	−5.40 (6.01)***	0.84 (0.33–1.35)	1.06 (0.54–1.58)	1.51	1.18	0.26	0.21
	CBT	13.06 (4.15)	9.92 (5.98)	8.84 (4.97)	−3.15 (5.45)***	−4.22 (5.45)***	0.61 (0.11–1.11)	0.92 (0.41–1.43)	(−0.53 to 3.56)	(−0.82 to 3.18)	(−0.09 to 0.60)	(−0.14 to 0.55)

Note. BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; MADRS = Montgomery and Asberg Depression Rating Scale; PHQ-9 = Patient Health Questionnaire 9 Items; Post = Post-test; Pre = Pre-test.

[a]Negative values indicate improvement in symptoms; [b]Cohen's *d* based on pooled standard deviation; [c]All in favour of BPT; ***Repeated measures ANOVA indicates a significant difference ($p < .001$) within the group.

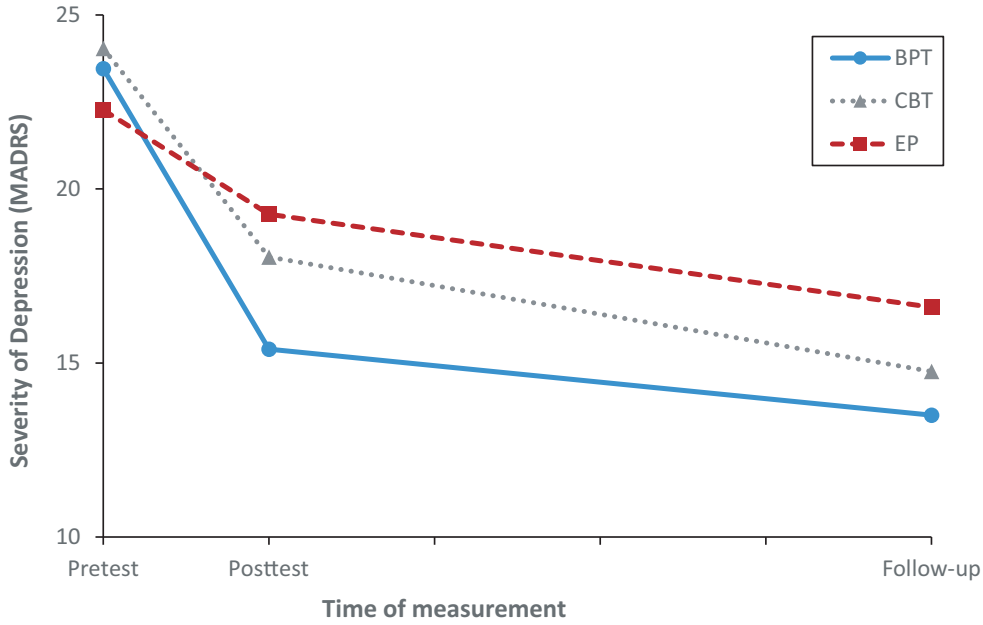

Figure 2. Changes in the severity of depression (MADRS) over 3 measurement points for the ITT sample. BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; EP = home-based exercise programme; ITT = intention to treat; MADRS = Montgomery–Åsberg Depression Rating Scale. After post-test, 20 patients from the CBT group and 27 patients from the EP group took part in BPT.

Between the end and the beginning of the intervention period (post-test – pre-test), participants in the BPT group showed an average difference of −4.63 (*SD* 6.13) points on the PHQ-9, whereas participants in the CBT group showed a difference of −3.46 (*SD* 5.67) PHQ points. Thus, the mean difference between the two groups was 1.17 PHQ points with a 95% CI of −0.70 to 3.03. The NI of BPT in comparison with CBT for the PHQ-9 scores was accepted because the lower bound of the 95% CI fell above the lower bound of the predefined margin of −1.9 PHQ points (Figure 5).

Non-inferiority at follow-up

The between-group difference between the initial CBT and BPT groups of 0.67 MADRS points (SEM 1.65) with a 95% CI of −2.58 to 3.92 had a lower bound that fell above the lower bound of the margin of −3.0 MADRS points defined by clinical relevance (see above); hence, NI was accepted (Figure 6). In the hierarchical regression analysis, participants who received additional psychotherapy between post-test and follow-up were not included in the final model; only the MADRS pre-test value was significant ($p = .004$).

Secondary outcomes

Secondary outcomes before and after the intervention period are presented in Table 4. Significant changes ($p < .01$) between pre-test and post-test were found in the BPT group for all of the secondary variables, namely, health-related quality of life, coping, body image, anxiety, self-efficacy, global self-esteem, and interpersonal sensitivity. In the CBT group,

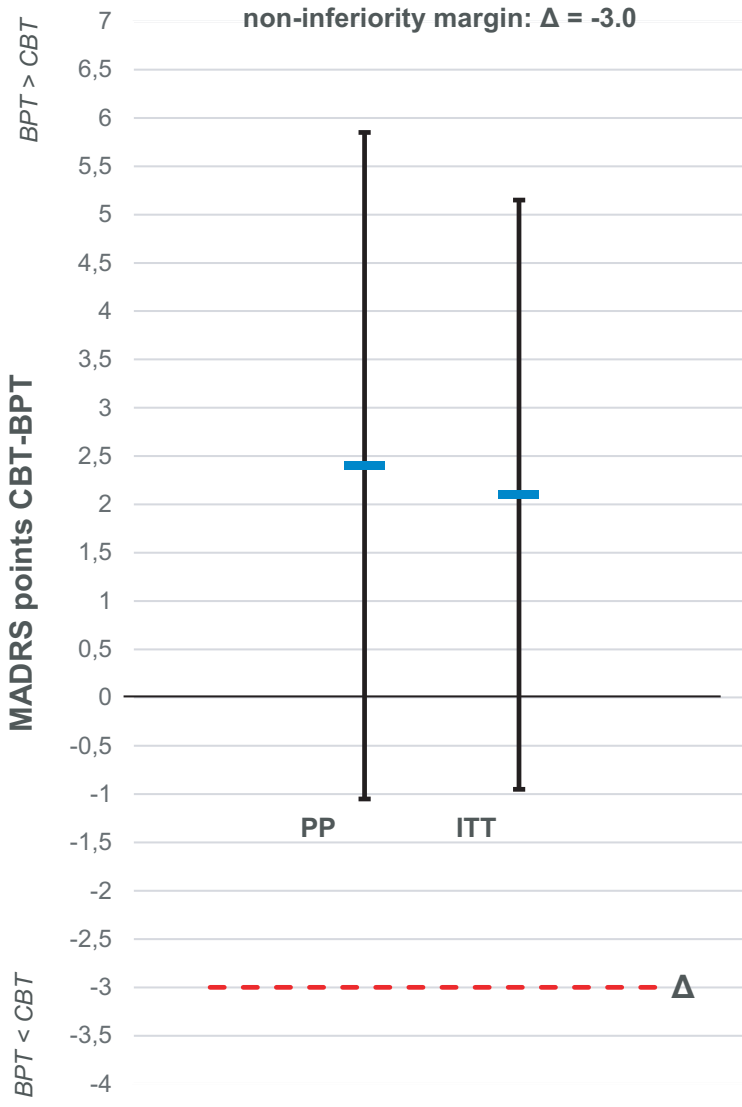

Figure 3. Non-inferiority trial comparing BPT with CBT directly after therapy using the MADRS and the margin of clinical relevance (3 points). BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; ITT = intention to treat; MADRS = Montgomery–Åsberg Depression Rating Scale; PP = per protocol.

significant changes ($p < .01$) were found for all of the variables except body image ($p = .195$). We found no evidence of differences between the groups (BPT vs. CBT) on any of the secondary variables.

Sensitivity analyses for PP

We computed sensitivity analyses for both outcomes (the PHQ-9 and MADRS) and all of the margins in the PP sample. All of the analyses resulted in comparable findings

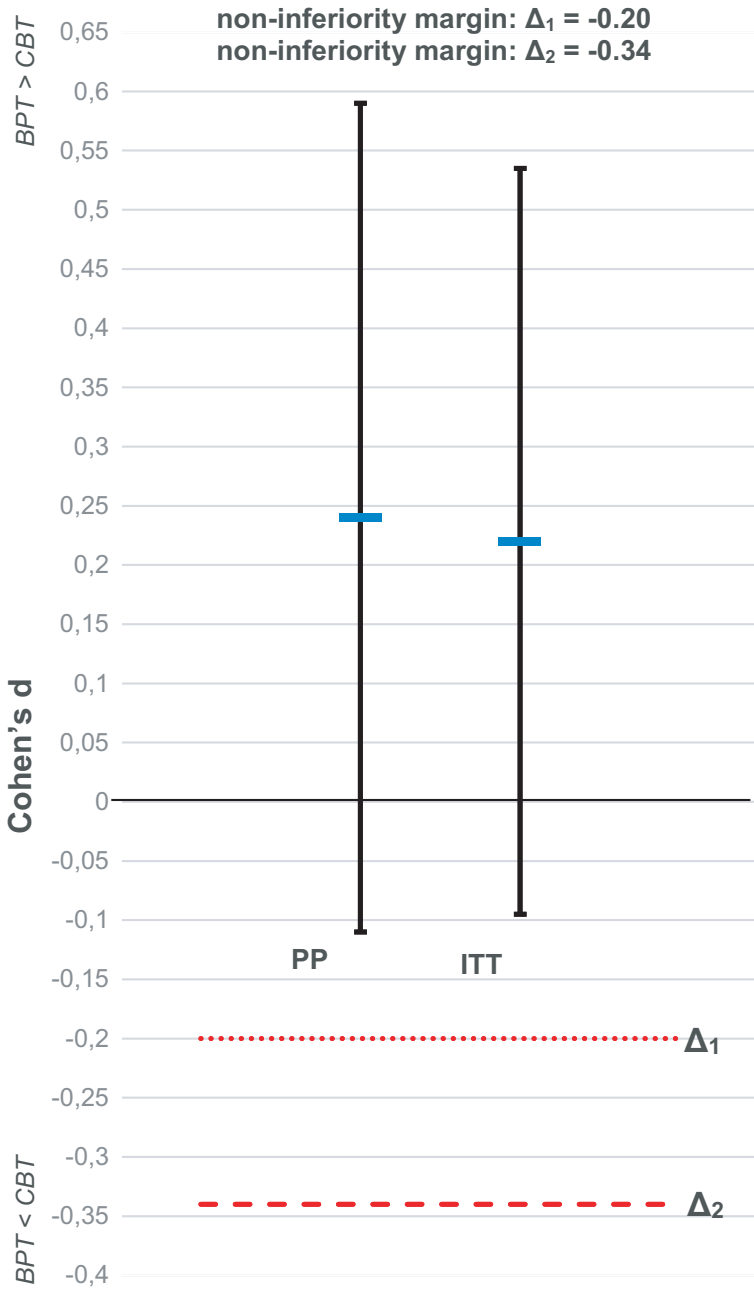

Figure 4. Non-inferiority trial comparing BPT with CBT directly after therapy using the MADRS and the margins from the literature (Cohen's *d*). BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; ITT = intention to treat; PP = per protocol.

(Figures 3–6). NI was accepted regarding the PP data for the margin of −3.0 MADRS points at post-test (mean between-group difference 2.36 points, SEM 1.73, 95% CI [−1.06,

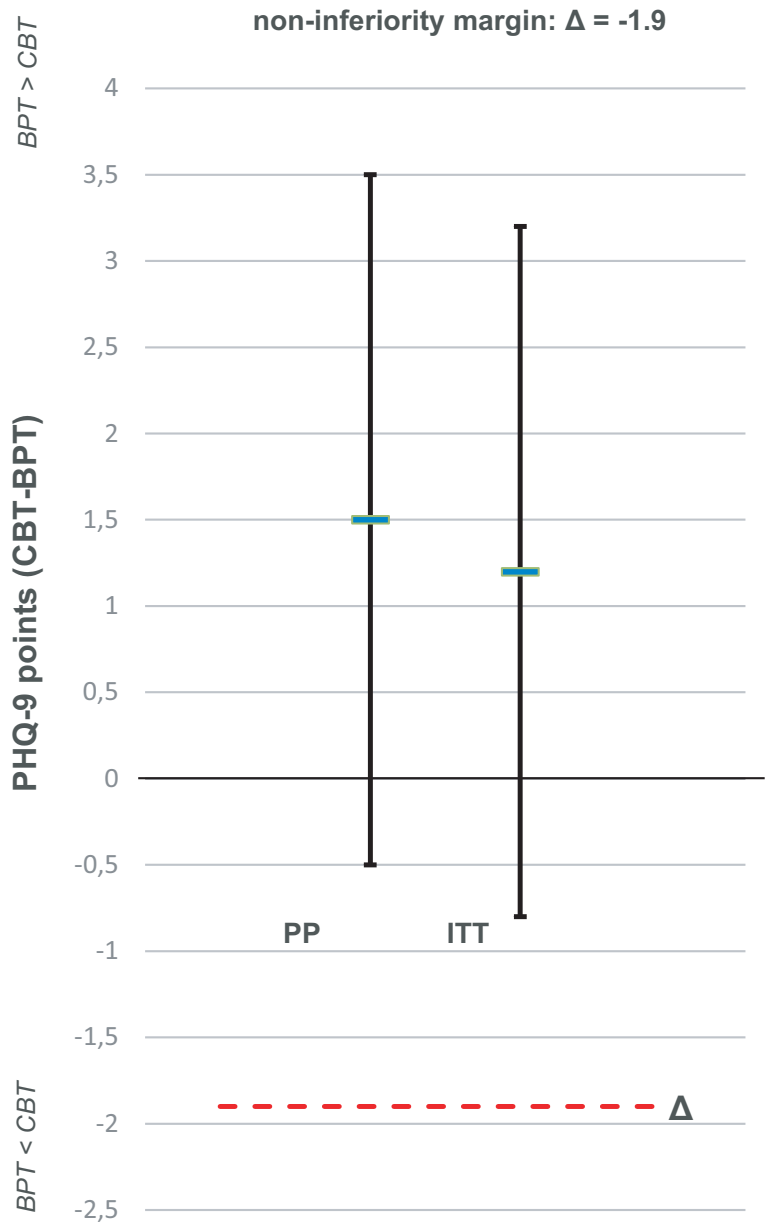

Figure 5. Non-inferiority trial comparing BPT with CBT directly after therapy using the PHQ-9 and the margin from the literature. BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; ITT = intention to treat; PHQ-9 = Patient Health Questionnaire 9 Items; PP = per protocol.

5.78]) and follow-up (mean between-group difference 1.23 points, SEM 1.86, 95% CI [−2.44, 4.91], see Table 3), for the PHQ-9 with a margin of −1.9 PHQ points (mean between-group difference 1.51 points, SEM 1.03, 95% CI [−0.53, 3.56]), as well as for the MADRS with the two margins of Cohen's *d* values of −0.2 and −0.34 (Cohen's *d* for the mean between-group difference was 0.24, 95% CI [−0.11, 0.59]).

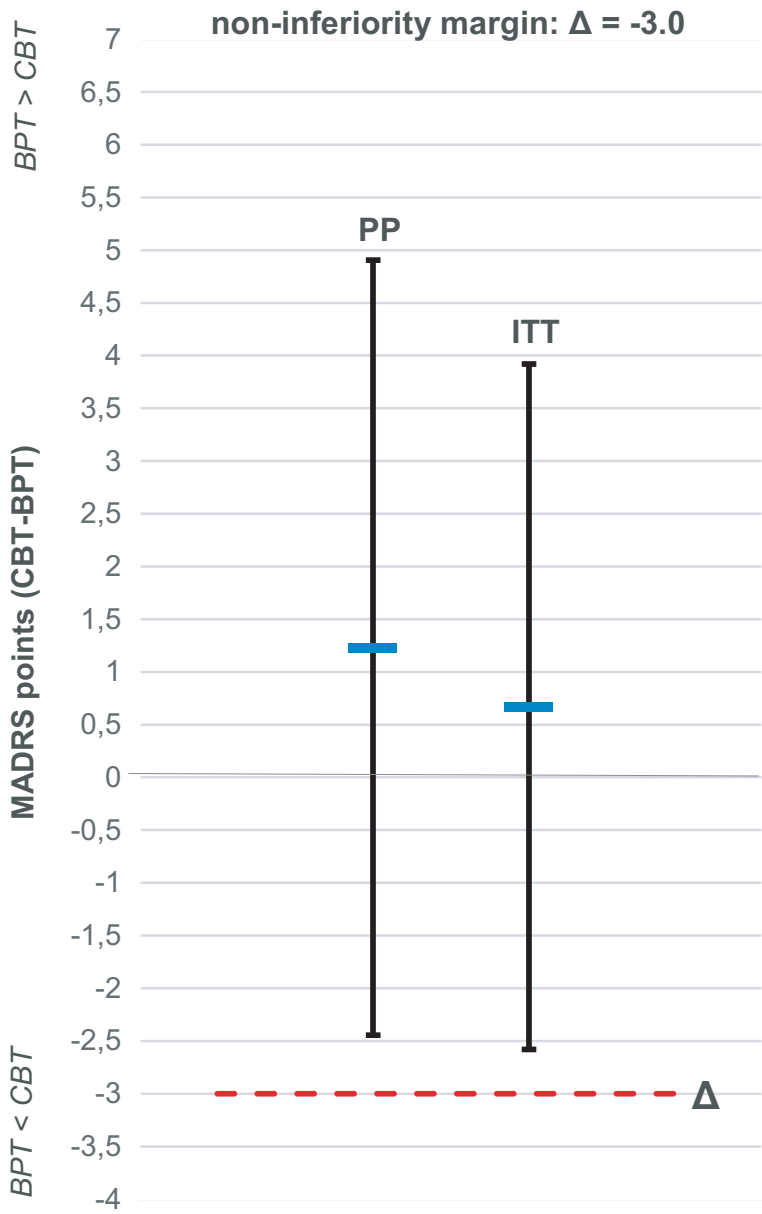

Figure 6. Non-inferiority trial comparing BPT with CBT at follow-up using the MADRS and the margin of clinical relevance (3 points). BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; ITT = intention to treat; MADRS = Montgomery–Åsberg Depression Rating Scale; PP = per protocol.

Discussion

The primary goal of this paper was to compare group BPT with established treatment options, namely, group cognitive behavioural therapy (CBT). A total of 156 patients participated for 10 weeks in one of the two intervention groups (BPT and CBT).

Table 4. Secondary outcomes at pre-test and post-test (ITT)

Variable	BPT (n = 79)			CBT (n = 77)			Between-group difference, CBT-BPT[b]	Between-group effect size[c]	Independent t-test
	Pre, M (SD)	Post, M (SD)	Post–pre[a], ΔM (SD)	Pre, M (SD)	Post, M (SD)	Post–pre[a], ΔM (SD)	M (95% CI)	$\lvert d \rvert$	p
Secondary outcomes									
Health-related QoL (EQ-5D)	52.09 (16.52)	61.88 (17.50)	9.80 (15.85)***	50.06 (16.33)	58.29 (17.12)	8.22 (17.26)***	−1.57 (−6.81 to 3.67)	0.10[d]	.55
Coping (FERUS)	33.15 (7.13)	36.16 (8.16)	3.01 (6.80)***	33.69 (7.39)	37.15 (7.28)	3.46 (6.33)***	0.45 (−1.63 to 2.53)	0.07	.67
Body image (FKB-20)	23.72 (6.73)	26.40 (8.52)	2.68 (6.48)***	24.42 (6.58)	25.42 (7.13)	1.00 (6.74)	−1.68 (−3.77 to 0.41)	0.25[d]	.12
Anxiety (GAD-7)	10.73 (4.08)	7.77 (4.18)	−2.97 (4.22)***	10.53 (3.79)	8.65 (4.17)	−1.88 (3.85)***	1.09 (−0.19 to 2.37)	0.27[d]	.10
Self-efficacy (GSE)	21.96 (4.55)	25.00 (5.36)	3.03 (4.90)***	23.17 (5.25)	25.61 (4.61)	2.44 (4.32)***	−0.59 (−2.05 to 0.87)	0.13[d]	.43
Global self-esteem (R-SES)	13.61 (5.44)	16.71 (5.46)	3.11 (4.07)***	14.04 (5.28)	16.74 (4.82)	2.71 (3.99)***	−0.40 (−1.68 to 0.87)	0.10[d]	.53
Interpersonal sensitivity (SCL-90); T-value	68.57 (8.52)	65.34 (8.87)	−3.23 (6.20)***	68.45 (7.55)	64.35 (8.61)	−4.10 (7.71)***	−0.88 (−3.09 to 1.33)	0.13	.44

Note. BPT = bouldering psychotherapy; CBT = cognitive behavioural therapy; EQ-5D = EuroQol Five Dimension Questionnaire; FERUS = Questionnaire on Resources and Self-Management Skills; FKB-20 = Body Image Questionnaire; GAD-7 = Generalized Anxiety Disorder 7; GSE = General Self-Efficacy Scale; ITT = intention to treat; Post = Post-test; Pre = Pre-test; QoL = Quality of life; R-SES = Rosenberg Self-Esteem Scale; SCL-90-R = Symptom Checklist-90-revised.
[a]Differences between pre-test and post-test: negative values on the GAD-7 and SCL-90 indicate improvement in symptoms, positive values on the EQ-5D, FERUS, FKB-20, GSE, and R-SES indicate positive effects; [b]No significant differences between BPT and CBT; [c]Cohen's d based on pooled standard deviation; [d]Indicates Cohen's d values in favour of BPT; *** indicates a significant difference between pre-test and post-test within the group ($p < .001$).

Depression severity was assessed with the MADRS before and after the treatment. The non-inferiority of BPT was accepted for all predefined margins directly after the end of therapy as well as one year after. Thus, we found that the positive effect of BPT in reducing depressive symptoms in outpatients with depression is not inferior to the effect of CBT. This paper is part of a larger research project in which we also tested a superiority hypothesis for BPT compared with a home-based exercise programme (EP). The test of the superiority hypothesis is published in Karg et al. (2020). It should be noted that the two papers are interrelated as the participants overlap to some extent (BPT group).

To ensure clinical relevance, one of the margins used to test for non-inferiority was chosen strictly on the basis of clinical relevance (i.e., 3 points on the MADRS) and was smaller than half a severity grade and smaller than the 5-point margin used in the literature (Hermens et al., 2007). Cohen's *d* for the BPT group compared with the CBT group was still 0.21 (ITT sample) to 0.24 (PP sample) in favour of BPT. The benefits of BPT were maintained until at least one year after the end of therapy, such that the depression scores were stable at eight to nine points below the level before therapy, which is around one severity grade. This finding adds to previous evidence for the efficacy of bouldering in lowering depression (Kleinstaeuber, Reuter, Doll, & Fallgatter, 2017; Mehl & Wolf, 2008; Mollenhauer, Doll, Renz, & Luntz, 2011; Schnitzler, 2009; Wallner, 2010). As the BPT concept focuses on established factors of action taken from CBT therapies, such as exposure training, problem solving, and the practising of new functional behaviour, BPT should not be seen as a different therapy but as an enrichment and implementation of CBT methods on the bouldering wall. Our results show that it is at least not inferior to CBT alone, a finding that is in line with current meta-analyses that have shown that the combination of physical activity and psychotherapeutic methods (i.e., behavioural therapies) might go beyond the effect of psychotherapy alone (Bourbeau et al., 2020) and that physical activity is effective in reducing depression (Cooney et al., 2013) to a comparable extent as antidepressants (Blumenthal et al., 2007) or psychotherapy alone. Both therapies in this study are group therapies. The therapies were administered in parallel settings (10 sessions with a duration of 120 min, 2 therapists, a fixed sequence involving introduction, action, and closure phases), but the contents were developed independently. The effectiveness of group CBT at the end of treatment was previously shown to be slightly below that of individual CBT, but at follow-up, this difference disappeared (Cuijpers, van Straten, & Warmerdam, 2008; DGPPN, 2015; Thimm & Antonsen, 2014).

All of the secondary variables we assessed (health-related quality of life, coping, body image, anxiety, self-efficacy, global self-esteem, and interpersonal sensitivity) showed significant changes between pre- and post-test in the BPT group. These findings are in line with the literature, which has already demonstrated effects of sports interventions, and bouldering in particular, on several psychological variables (Buechter & Fechtelpeter, 2011; Fruhauf et al., 2019; Karg et al., 2020; Kratzer, Luttenberger, Karg-Hefner, Weiss, & Dorscht, 2021; Luttenberger et al., 2015; Mazzoni et al., 2009; Wallner, 2010). For self-efficacy and trait anxiety, especially Wolf and Mehl (2011) were able to show long-lasting effects of a climbing intervention. Also in the CBT group, most of the secondary outcomes showed significant changes between pre- and post-test, with the exception of the body image variable. Thus, body image seems to be particularly altered by BPT and should be given special attention in future research on the effects of BPT.

The dropout rates (BPT 19%, CBT 16%) were comparable to recent studies on group therapy in depression (Bains, Scott, Kellett, & Saxon, 2014; Thimm & Antonsen, 2014). This finding is especially notable as BPT also requires a minimum level of physical fitness

for participating. One third of the patients who dropped out of the BPT group ($n = 5$) did so because of physical complaints that prevented them from bouldering (e.g., broken arm after a bicycle accident, distorted ankle). On the one hand, the similar dropout rates show that adherence to BPT is similar to adherence to other group therapies. On the other hand, there are of course limitations to the generalizability of BPT because it is only suitable for patients with a certain minimum level of physical fitness (e.g., BMI < 40, no pregnancy, no paralysis). It might be especially difficult to generalize to patients with physical impairments, and the BPT programme should be adapted for this group. As there are already some bouldering programmes for physically handicapped individuals, such an adaptation is probably possible (Kim & Seo, 2015; Mazzoni et al., 2009; Schram Christensen, Jensen, Voigt, Nielsen, & Lorentzen, 2017).

The main limitation of the study is that the inclusion and exclusion criteria were mainly assessed via self-report. In the pre-test interviews after participants were accepted into the study, trained raters assessed depression severity with high inter-rater reliability. Also, positive results might be limited to individuals who were interested in bouldering and might not be representative of all depressed patients (selection bias). We announced recruitment meetings through press releases, our homepage, posters, flyers, and Facebook. We fully described all the groups, including the control groups, but we cannot exclude the possibility that the BPT may have stood out due to its novelty. 84.7% of the study participants rated BPT group participation as pleasant or very pleasant in comparison with 47.9% who rated CBT group participation as pleasant or very pleasant. This is important because treatment preferences are significantly associated with adherence (Raue, Schulberg, Heo, Klimstra, & Bruce, 2009), whereas there are conflicting results on the impact of treatment preferences on outcomes (Mergl et al., 2011; Raue et al., 2009). In comparison with current samples of depressive patients in Germany, however, there is no evidence of differences in age or gender (Altmann et al., 2015; Dorow et al., 2018; Hölzel et al., 2014). The average BMI in our sample, which was 24.2, was slightly smaller than the BMI of the German population, which is 26.5 for women and 27.2 for men (Mensink et al., 2013), but of course this finding may be explained to some extent by the exclusion of individuals with a BMI above 40. Future research should clarify what percentage of depressed patients would consider BPT as their method of choice in addition to testing BPT in a more independent, unbiased sample. Around two thirds of our sample had already experienced previous attempts at treating their depression with therapies other than BPT. This finding could be an indication that even patients with previous therapy experience can be reached by BPT and can also benefit from a BPT group. A third limitation is that participants were free to choose to accept other therapeutic offers (open phase) after the post-test. Former participants of all groups could participate in any therapies offered by the health service system, including group or individual psychotherapy. Former participants of the CBT and EP groups were allowed to participate in a BPT group if they asked to do so. Thus, as is often the case, the follow-up data cannot be interpreted as a pure difference between CBT and BPT. Participation in additional psychotherapy, including BPT after t1, were almost equally distributed between the groups. In our study, the BPT group showed greater improvement than the CBT group (even though the difference was nonsignificant), so when CBT participants received additional BPT, the results of the former CBT group improved even more at follow-up, thus making it harder to claim non-inferiority for BPT (because these participants were still classified as belonging to the CBT group). We therefore decided not to remove the CBT+BPT patients as it would reduce our power and break up the randomization. But we believe that our approach is the most conservative because it tends

to underestimate the effect of BPT. In the regression analyses, the only significant predictor of the follow-up depression value was the pre-test depression value.

Given that our BPT is a combination of bouldering elements and psychotherapeutic elements, we cannot clarify whether the effects in lowering depression can be attributed to bouldering alone, to other elements of the therapy, or to the combination of the two (which seems most probable). Therefore, future research should place a special focus on the factors of action and positive side effects of BPT.

Conclusions

We developed BPT, which combines established therapy methods from cognitive behavioural therapy with exercises from bouldering and mindfulness to provide a therapy that offers the advantages of low stigma, positive side effects from physical activity, and the inclusion of body-related techniques. We were able to show that BPT is equally as effective in the treatment of depression as CBT. The positive effects of BPT are maintained until at least 12 months after the end of therapy. Thus, BPT is a promising approach for broadening the therapeutic field of therapies for depression and should be tested further in future high-quality studies.

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Conflicts of interest

All authors declare no conflict of interest.

Author contribution

Katharina Luttenberger: Conceptualization (equal); Formal analysis (equal); Funding acquisition (equal); Investigation (equal); Methodology (equal); Resources (equal); Visualization (equal); Writing – original draft (equal). **Nina Karg-Hefner:** Conceptualization (equal); Data curation (equal); Investigation (equal); Writing – review & editing (equal). **Matthias Berking:** Conceptualization (equal); Supervision (equal); Writing – review & editing (equal). **Leona Kind:** Data curation (equal); Formal analysis (equal); Methodology (equal); Writing – review & editing (equal). **Maren Weiss:** Formal analysis (equal); Methodology (equal); Writing – review & editing (equal). **Johannes Kornhuber:** Conceptualization (equal); Project administration (equal); Resources (equal); Supervision (equal); Writing – review & editing (equal). **Lisa Dorscht:** Conceptualization

(equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Visualization (equal); Writing – original draft (equal).

Data availability statement

The data that support the findings of the study are available at Zenodo: DOI https://doi.org/10.5281/zenodo.5645184.

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