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## The Associations between Climbing and Mental Health and Wellbeing: A Mixed-Methods Scoping Review

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### **Abstract**

The increasing prevalence of mental health issues is a global concern, and implementing low-cost, effective, population-level interventions is critical. Physical activity interventions, including climbing, hold promise as one way to bridge this gap. Climbing is a non-mainstream form of physical activity that is gaining popularity and is being increasingly investigated as a potential mental health intervention, with promising findings. As this field of enquiry grows, the range in methods, intervention components, outcome measures, and participant characteristics is increasing, making cross-study comparisons challenging. There is a need to characterise the literature and identify common methods and gaps in knowledge. PsycInfo, CINAHL, Web Of Science, Embase, MEDline, Scopus, SportDISCUS were searched for studies including climbing and a measure of mental health or wellbeing. CENTRAL and clinicaltrials.gov were searched for ongoing trials. All study designs were eligible for inclusion. Grey literature and reviews were excluded. All screening, data extraction, and quality assessments occurred in duplicate. A narrative synthesis was conducted. Fifty-nine papers were eligible for inclusion, covering a wide range of study designs (interventions, experimental studies, descriptive studies, qualitative and mixed-methods studies), contexts, and samples (clinical/non-clinical, climbers/non-climbers, adults/children and adolescents). Overall, climbing interventions and participation seemed to have benefits for mental health and wellbeing across a range of individuals. It is unclear what the mechanisms leading to these benefits might be. Further high quality research is warranted to investigate exactly how, where, when, and for who climbing can improve mental health and wellbeing, and to investigate theories of change.

*Keywords:* rock-climbing; bouldering; mental health; quality of life; wellbeing; stress

## Introduction

The World Health Organisation (WHO, 2004) defines mental health as “*a state of well-being in which the individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community.*” Good mental health is distinguished by its alliance to positive affect, while mental ill-health is marked by feelings of sadness, loneliness, anger, and poor self-concept. It is reported that at least 1 in 4 people aged 18 and older have been affected by a diagnosable mental health issue in the last 12 months, with depression (9.5%) and anxiety (18%) reported to be the leading causes of individuals seeking mental health support (John Hopkins Medicine, 2022; WHO, 2021). Trend data recorded between 2007 and 2017 indicated a 13% increase in diagnosable mental health issues (WHO, 2019a), and in the wake of COVID-19 it has been estimated that there has been a 25% growth in reports of anxiety and depression (WHO, 2022). Despite the increasing prevalence, mental health systems have failed to respond effectively and efficiently. This has led to significant gaps between supply and demand, with poor treatment coverage in some countries, and inconsistent access to good quality mental health care in others (WHO, 2019a). The implementation of low-cost, effective, population-level interventions are critical.

Physical activity interventions hold promise as one way to bridge this gap. The positive relationship between physical activity and mental health is well established (Paluska & Schwenk, 2000), and the relative low-cost implications to public resources associated with implementing this type of intervention at scale make it an attractive solution (Richardson et al., 2005). National and international public health guidance currently recommends the use of physical activity programmes to help adults manage the symptoms of mild-to-moderate mental health difficulties (NICE, 2022; WHO, 2019b; WHO, 2020). Further guidance also acknowledges the benefits of physical activity on general physical health and quality of life for all ages (NICE, 2013; WHO, 2020). However, this relationship is not straightforward, nor is it always conclusive. There is moderation of causation through several factors, including context, time, frequency, intensity, and type of physical activity (Lubans et al., 2016). Evidence from a large meta-analysis suggests that the situational context in which exercise is conducted is paramount and should be considered when designing and implementing effective policies and interventions (White et al., 2017). A generic prescription is not sufficient: interventions

that worked for some people once may not work for other people, or even the same people at a different time (Rebar & Taylor, 2017). Instead, there is a need to tailor recommendations to the individual to enhance their opportunity and commitment to engage in physical activity that they find meaningful and enjoyable, and will remain motivated to participate in.

In recent years climbing (including rock-climbing and bouldering) as a form of physical activity has been explored as a potential therapeutic strategy for preventing and treating mental ill-health and improving quality of life (QoL). Climbing may offer unique benefits compared to more mainstream forms of physical activity, due to its versatility in how, when, where, and with whom it can be participated in. Individuals can climb alone, with a partner, or in groups; indoors or outdoors (the latter offering additional mental health advantages through connecting with nature; Capaldi et al., 2015); and they can choose the level of difficulty they desire at the time, choosing easier climbs or pushing themselves physically/mentally and even competing internationally. Popularity in the sport increased by 10% between 1999 and 2009 and is expected to increase by a further 50% by 2050 (Lorite et al., 2017). Moreover, climbing is now being recommended by public health services as a potential method for alleviating symptoms of mental health problems (NHS, 2020).

Climbing may increase important psychological skills for reducing mental ill-health/distress, due to the need to problem-solve, cope with fear, set goals and increase mastery in order to get to the top of a climb: early evidence suggests that experienced rock-climbers have enhanced coping skills (Young & Knight, 2014). Furthermore, climbing naturally involves mindfulness: focusing on the present moment is paramount to not falling off. Climbing may therefore enhance mindfulness (Wheatley, 2023), which itself has known mental health benefits (Enkema et al., 2020). Congruently, psychologists and other healthcare professionals propose that climbing has the potential to improve self-esteem, focus, motivation, and social relationships, and reduce fear and limits, with benefits gained on the wall transferred into everyday life (Frühaufer et al., 2021). Climbing may, therefore, improve wellbeing through satisfying our three basic psychological needs: autonomy, competence, relatedness (Deci & Ryan, 1985).

The therapeutic effect of climbing for mental health has been gaining attention both within and outside of academia. In addition to a multitude of blogs and magazine articles detailing subjective accounts of links between climbing and mental health (BMC, 2016; BMC, 2017; UKC, 2017), there have been some RCTs and pilot studies quantitatively investigating this link for in- and out-patients of

mental health services. These studies reported promising results, with decreases in symptoms of depression, anxiety, and negative mood, and increases in positive mood, up to 12 months later (Aras & Ewert, 2016; Kleinstäuber et al., 2017; Schwarz et al., 2019). However, as the evidence base is growing, the range in methods, intervention components, outcome measures, and participant characteristics is increasing, making cross-study comparisons challenging. Given this, and the increased interest in using climbing as an intervention for improving mental health, the need to characterise the literature and identify common methods and gaps in knowledge, is evident.

Attempts to collate the growing evidence base thus far have been narrow in focus, with three existing reviews having key limitations: 1) only including interventional studies and/or RCTs in clinical populations (Gassner et al., 2022; Liu et al., 2022), thus excluding a wide range of literature using different methods to examine the broader associations between climbing and wellbeing; 2) focussing solely on depression and anxiety (Zieliński et al., 2018), thus excluding evidence on broader measures of wellbeing, mental health, stress, and quality of life, 3) not employing rigorous methods such as double screening, thus key articles may have been missed (Liu et al., 2022).

Therefore, the purpose of the current scoping review is to examine the existing evidence concerning the relationship between climbing and mental health and wellbeing, to identify gaps and make recommendations for future research and practice. Specifically it aims to:

1. Identify the types of studies exploring associations between climbing, mental health, wellbeing, stress, and/or quality of life.
2. Examine how research is conducted within this field, including types of study designs, and the content and context of the interventional studies.
3. Identify and analyse knowledge gaps and areas for future research.

## **Methods**

The 'Preferred Reporting Items for Systematic Reviews and Meta-Analyses: Extension for Scoping Reviews' (PRISMA-ScR; Tricco et al., 2018) was used as a guideline along with the Joanna Briggs Institute's protocol for scoping reviews (Aromataris & Munn, 2020), see Supplementary File 1 for the PRISMA-ScR checklist. A protocol was prepared in advance and published on the Open Science Framework (OSF; DOI 10.17605/OSF.IO/UDFXA).

## **Search Strategy and Information Sources**

We searched seven scientific literature databases (MEDLINE, PsychINFO, SCOPUS, EMBASE, Web of Science, SPORTdiscus, and CINAHL) on 25th of June 2021 with no restriction on date. CENTRAL and clinicaltrials.gov was searched for ongoing trials on 2nd May 2023. Keywords were identified through preliminary searches and reviews on similar topics, and our final search strategy was peer-reviewed by information specialists at two institutions. We used keywords and MESH terms related to: climbing, bouldering, adventure therapy, mental health, wellbeing, quality of life, stress. See Appendix A for MEDLINE search terms and Open Science Framework (DOI 10.17605/OSF.IO/UDFXA) for all databases.

## **Eligibility criteria**

According to our inclusion criteria (Appendix B), articles published up to 25th of June 2021 using quantitative, qualitative, and mixed-methods were included. Reviews, opinion papers, commentaries, letters, and grey literature were excluded. Articles were included if they contained climbing either as an intervention (sole or complex), or recreationally, and also included a measure of mental health/illness or wellbeing (including stress, burnout, and quality of life). Studies of adults and children were included, and healthy populations were included where a measure of mental health/wellbeing was included and linked to the climbing construct/intervention. Climbing in its most common, accessible forms was included (e.g. bouldering, indoor wall climbing, sport climbing). Mountaineering, scrambling, alpine climbing, big-wall climbing, hiking, and trekking were excluded.

A decision was made post-hoc to exclude adventure therapy studies, as after reviewing multiple of these papers it was apparent that climbing was not always used or described: where it did explicitly form part of the adventure therapy, context, content, and dose were not described nor were effects of climbing distinguishable from all other included activities.

## **Study Screening, Selection and Data Charting**

All returned searches were saved into Endnote and duplicates removed. We checked our sentinel reference lists to confirm the searches included all of the key papers. Following this, all references were uploaded onto Rayyan for screening. Titles, abstracts, and full texts were screened in duplicate with all authors screening a third of articles each. Data extraction was completed in duplicate, with LH extracting 100%, and all co-authors extracting 20% each. Hand searching

references of included papers was conducted, along with forward citation searching. Data was charted in table form in Microsoft Excel, including information on participant characteristics, study design, outcome measures, key findings. Articles were then categorised into type of study (therapeutic climbing interventions, experimental studies, qualitative and mixed-methods research, and descriptive studies), and population (clinical/non-clinical; adult/child; climbers/non-climbers). A narrative synthesis of the evidence was conducted using these categories.

### **Quality Assessment**

All articles were quality assessed in duplicate (20% by 5 authors) using the Mixed Methods Appraisal Tool (MMAT), version 2018 (Hong et al., 2018), to determine the range in quality of the literature in this quickly growing field of study. Discrepancies were discussed and where needed arbitrated by a third author. Studies of all qualities are included, and their quality ratings and flaws discussed when reflecting on the impact of their findings in the results and discussion sections.

## **Results**

### **Search Results**

The initial database search returned 14370 articles, with 13326 retained after removing duplicates. After title and abstract screening, 334 articles proceeded to full text screening. Of these, 281 were excluded (see Figure 1 for exclusion reasons). Fifty-three articles went through to data extraction, upon which five were found to be ineligible (papers and exclusion reasons detailed in Appendix C), giving a total of 48 papers for inclusion. Hand searching of references of included papers did not identify any additional papers. Forward citation searching identified a further 2132 papers for screening. After duplicates were removed, titles, abstracts, and full-texts were screened, giving a further 13 papers for data extraction. Upon data extraction, two were deemed ineligible (see Appendix C). Therefore forward citation identified an additional 11 papers, giving a total of 59 papers for inclusion in this review. Searches of CENTRAL and Clinicaltrials.gov identified two ongoing trials.

### **Inclusion of Sources of Evidence**

A total of 59 articles were eligible for inclusion, with studies conducted in mainland Europe ( $n = 33$ , 10 of which were in Germany; See OSF Supplementary File DOI 10.17605/OSF.IO/UDFXA). Twenty articles explored climbing as a therapeutic intervention for improving mental health and/or



quality of life or wellbeing, using a range of methods from case studies to randomised controlled trials (Table 1). Twenty-five articles, covering 31 individual studies, were experimental designs aiming to assess the effects of different climbing-related variables (e.g. lead versus top-roping) on anxiety and stress (Table 2). Eleven articles were descriptive studies using quantitative methods, mainly questionnaires, with a wide range of study aims including exploring the impact of climbing on wellbeing and life satisfaction (Table 3). Two articles used qualitative methods (Boudreau & Gibbons, 2019, Heirene et al., 2016) and one article employed mixed methods (Boorman, 2008) with varying aims. Sample sizes ranged from individual case studies (DelGrande et al., 2020) to 1719 participants (Ardahan & Mert, 2013).

### **Summary of study quality (MMAT Findings)**

There was a wide range in study quality across all articles, from 0/5 (Kessell, 1994) to 5/5 (Heirene et al., 2016; Luttenberger et al., 2022; Velikonja et al., 2010; Pijpers et al., 2005; Pijpers et al., 2006; Sanchez et al., 2010; Tukaiev et al., 2020; Wheatley, 2023), see Supplementary File 2 and Appendix D. Across the RCTs, the most common limitation was not reporting whether participants or assessors were blinded to participants' condition. The most common limitations of non-RCTs and quantitative descriptive studies were related to sampling: many did not report on whether there was a non-response bias (or they had a high non-response bias), and/or they did not state whether the sample was representative of the wider population. Other common limitations were not stating whether all outcome data were presented and not clarifying if the study was conducted per protocol.

## **Review Findings**

### **Climbing as a therapeutic intervention**

#### ***Samples***

Of the 20 therapeutic climbing intervention studies, the mean sample size was 57 (range = 1 to 233) (Table 1). A variety of populations were studied, with the majority (18/20) being in adults. Thirteen studies were in clinical adult populations, with six focused on mental health conditions: of these, five studies involved out-patients with depression (Karg et al., 2020, Luttenberger et al., 2015; Luttenberger et al., 2022; Schwarz et al., 2019; Stelzer et al., 2018), one in in-patients with major depression or bipolar disorder (Kleinstäuber et al., 2017). Seven studies were in clinical adult populations with physical health conditions across a range of

diagnoses including, Haemophilia (Schroeder et al., 2018; Stemberger et al., 2015) and Gynaecological Cancer (Crawford et al., 2016). Two studies were in clinical samples of children: children with cerebral palsy (Schram Christensen et al., 2017), and child and adolescent in-patients of a mental health unit (Frühauf et al., 2021). Finally, five studies were in adults with no reported physical/mental health conditions (Aras & Ewert, 2016; Gallotta et al., 2015; Özen, 2015; Özen, 2018; Wheatley, 2023).

### ***Intervention details (Setting, content, length)***

The majority of interventions (17/20) were delivered at indoor climbing centres, either public climbing walls or within health services buildings, with most using bouldering (only (n=8) or in addition to ropes (n=3)). Two further interventions included both indoor and outdoor climbing (Özen, 2015; Stemberger et al., 2015), and one did not specify where the climbing took place or the style of climbing (Özen, 2018).

Six of the bouldering interventions also included psychoeducational elements and/or mindfulness (Karg et al., 2020; Luttenberger et al., 2015; Luttenberger et al., 2022; Schwarz et al., 2019; Stelzer et al., 2018, Wheatley, 2023) and two (Engbert & Weber, 2011; Gassner et al., 2022) were specific climbing interventions as a form of physiotherapy, with Gassner et al., (2022) also including additional physiotherapies off the wall (e.g. aqua therapy). The length of interventions ranged from one-off sessions (Frühauf et al., 2021; Kleinstäuber et al., 2017; Wheatley, 2023) to weekly sessions for 8.5 months (Stemberger et al., 2015), with the most common being weekly to three sessions a week, over two to three months (11/20; Aras & Ewert, 2016; Crawford et al., 2016; Gallotta et al., 2015; Karg et al., 2020; Luttenberger et al., 2015; Luttenberger et al., 2022; Özen, 2015; Schroeder et al., 2018; Schwarz et al., 2019; Stelzer et al., 2018; Velikonja et al., 2010).

### ***Comparators***

Six out of the twenty studies did not have a control group (Schram Christensen et al., 2017; DelGrande et al., 2020; Gassner et al., 2022; Schroeder et al., 2018; Stemberger et al., 2015), three employed waitlist designs (Luttenberger et al., 2015; Schwarz et al., 2019; Stelzer et al., 2018), two studies used 'usual care' as a control (Aras & Ewert, 2016; Crawford et al., 2016). Alternative interventions were used by some as comparators, including; a supervised fitness or exercise programme (Engbert & Weber, 2011; Gallotta et al., 2015); an unsupervised strength and conditioning session (Wheatley, 2023); a progressive muscle relaxation group (Kleinstäuber et al., 2017); yoga (Velikonja et al., 2010); walking and camping (Özen, 2018); swimming and an occupational therapy

group (Frühauf et al., 2021); Cognitive Behaviour Therapy group and an Exercise Therapy group (Karg et al., 2020; Luttenberger et al., 2022).

### **Outcome measures**

Given the focus of this paper on mental health, we are reporting only on the outcome measures relevant to this review (e.g. quality of life, wellbeing, mental health, stress). A wide range of measures were used, including commonly used, validated measures of mental health such as the Hospital Anxiety and Depression Scales (HADS; Zigmond & Snaith, 1983) measures of Quality of Life such as the EuroQoL-5D (EQ-5D; Rabin & de Charro, 2001), measures of affect e.g. Positive And Negative Affect Schedule (PANAS; Watson et al., 1988), and additional wellbeing measures such as the Flourishing Scale (Diener et al., 2010). Follow-up time points ranged from immediately post-intervention (12/20 studies: Aras & Ewert, 2016; Schram Christensen et al., 2017; Crawford et al., 2016; DelGrande et al., 2020; Engbert & Weber, 2011; Frühauf et al., 2021; Gallotta et al., 2015; Gassner et al., 2022; Kleinstäuber et al., 2017; Özen, 2015; Schroeder et al., 2018; Wheatley, 2023) to 12 months post-intervention (Karg et al., 2020; Luttenberger et al., 2022; Schwarz et al., 2019).

### **Findings**

A breakdown of findings by sample can be found in Table 1. Two medium quality non-RCTs of in-patients in mental health units found that a one-off climbing session significantly improved positive affect and decreased negative affect in children and adolescents (Frühauf et al., 2021), as well as also decreasing depressiveness in adults (Kleinstäuber et al., 2017) pre- to post-intervention. Five high-quality RCTs aiming to improve symptoms of depression across in- and out-patients of mental health units found significant improvements in depression scores (Karg et al., 2020; Luttenberger et al., 2015; Luttenberger et al., 2022; Schwarz et al., 2019; Stelzer et al., 2018). These studies all followed an 8 or 10 week Bouldering Psychotherapy (BPT) protocol involving structured sessions of psychoeducation, mindfulness, and behaviour change techniques such as problem solving.

Across five medium to high quality climbing interventions in non-clinical adult populations, (Aras & Ewert, 2016; Gallotta et al. 2015; Özen, 2015; Özen, 2018; Wheatley, 2023), of which four were in University students, improvements were seen in state anxiety and/or wellbeing and mindfulness measures immediately post climbing intervention. However, anxiety levels were in fact higher when measures were taken *during* rather than *after* the climbing activity (Özen et al., 2018).

Eight medium to high quality studies reported climbing interventions for specific patient groups, with all consisting of small sample sizes ( $n = 1 - 35$ ). Only two studies found a significant improvement in mental health or QoL scores post climbing interventions (DeIGrande et al., 2020; Engbert & Weber, 2011). The remaining six studies generally reported improvements that were non-significant for mental health and QoL.

In summary, 14/20 studies reported that climbing interventions (of varying length, intensity, and content) resulted in significant improvements in measures of depression, anxiety, wellbeing, affect, mindfulness and/or quality of life, across a range of clinical and non-clinical adult and child populations. The remaining 6/20 studies reported non-significant improvements.

## **Experimental designs**

### ***Samples***

The sample sizes across the 31 experimental studies (reported in 25 papers) were small, with the mean sample size being 26 participants (range = 5 to 214). Studies either investigated experienced climbers, or people who had not climbed before, and the findings are presented in these two categories below.

### ***Measures***

The Revised Competitive State Anxiety Inventory-2 (CSAI-2R; Cox et al., 2003) was the most commonly used measure (in 13/31 studies). Other measures included the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983; used in 7/31 studies) and the Perceived Stress Scale (PSS; Chan & Greca, 2013).

### ***Findings***

#### ***Climbers***

Fifteen studies of varying quality examined the effect of different climbing styles in intermediate to elite level climbers (Table 2). Most manipulations did not result in differences in state anxiety pre, during, or post climbing in experienced climbers (e.g. lead onsight vs. top-rope on-sight; - for definitions see Draper et al., 2015). However, three medium quality studies reported that on-sighting induced higher pre-climb anxiety than red-pointing (whether leading, top-roping, indoors or outdoors; Draper et al., 2008; Hardy & Hutchinson, 2007c; Limonta et al., 2020). Four out of seven low-medium quality studies reported that leading induced higher pre- and post-climb anxiety and lower self-confidence when compared to top-roping (Aras & Akalan, 2014; Hardy & Hutchinson, 2007b; Hodgson et al., 2009; Magiera et al., 2019).

One low/medium quality study reported that difficult climbs induced higher pre-climb anxiety than easy climbs, regardless of climbing style (lead/top-rope; Hardy & Hutchinson, 2007a).

Two medium-quality studies looked at the impact of additional stimuli when climbing, finding that climbers were more anxious when having to memorise words while climbing (Green et al., 2014) and after a loud noise was played whilst climbing (Villavicencio et al., 2021). The latter study also reported that females generally had lower self-confidence than males pre-climb, and after climbing in a 'fatigue' condition.

### *Non-climbers*

Across eight similar experiments (in four published medium to high quality articles), non-climbers were more anxious when traversing indoors at height compared to at a lower level (Nieuwenhuys et al., 2008; Pijpers et al., 2003; Pijpers et al., 2005; Pijpers et al., 2006). Three low to medium quality studies from the same research group used climbing and 'jumping into the rope' (the Heidelberg Risk Sport-Specific Stress Test; HRSST; Frenkel, Laborde, et al., 2019) to induce stress in non-climbers. All reported that the HRSST significantly increased state anxiety, even in participants who were high in 'sensation seeking' (Frenkel et al., 2018; Frenkel, Brokelmann, et al., 2019; Frenkel, Laborde, et al., 2019). Two medium to low quality studies reported that using imagery script (visualisation; Jones et al., 2002), and somatic relaxation training (Maynard et al., 1997) prior to climbing reduced perceived stress and cognitive anxiety, respectively.

## **Descriptive studies**

### ***Samples***

Of the 11 descriptive studies, the mean sample size was 271 (range 19 to 1719), with six studies employing surveys of climbers (Bailey et al., 2019; Bazancir et al., 2018; Ding & Schuett, 2013; Feher et al., 1998; Robinson, 1985; Sanchez et al., 2010). Two additional studies compared climbers to non-climbers to investigate differences in life satisfaction and stress resistance (Ardahan & Mert, 2013; Tukaiev et al., 2020, respectively). One study surveyed university students who had attended a 3-month indoor climbing course for beginners, to assess impact of climbing on psychological wellbeing (Hrušová & Chaloupská, 2019). One study surveyed gynaecological cancer survivors to assess participation and interest in rock-climbing and possible associations with posttraumatic growth (Crawford et al., 2015).

Finally, one study surveyed changes in self-esteem in women who had participated in a four-day rock-climbing experience and who had varying mental health diagnoses (Kessell, 1994).

### **Measures**

Ten out of eleven studies employed survey methods using mainly measures of anxiety or affective states (e.g., CSAI-2R, PANAS). One study used Electroencephalography (EEG) data in climbers to explore associations between state anxiety and performance during a bouldering competition (Bailey et al., 2019).

### **Findings**

A breakdown of results by sample can be found in Table 3. Across three out of four surveys of varying quality, climbers were found to have enhanced wellbeing, higher life satisfaction, lower trait anxiety, and higher stress resistance compared to non-climbers (Ardahan & Mert, 2013; Crawford et al., 2015; Robinson, 1985; Tukaiev et al., 2020). A medium-quality survey of gynaecological cancer survivors found no association between participation in climbing and posttraumatic growth (Crawford et al., 2015). In a large (but representativeness unknown) sample of Chinese climbers, Ding and Schuett's (2013) medium quality study reported that their main motivations for climbing included 'resting the mind', 'tranquillity' and 'releasing tension', whereas the social aspect of the sport was less important in this population. In two low quality surveys of non-climbers who participated in climbing courses, some improvements were reported on participants' psychological wellbeing, including improvements in feelings of discomfort and self-esteem (Hrušová & Chaloupská, 2019; Kessell, 1994).

Four medium to high quality studies assessed associations between anxiety and climbing performance, with mixed findings (Bailey et al., 2019; Bazancir et al., 2018; Feher et al., 1998; Sanchez et al., 2010). Bailey et al. (2019) reported that competition climbers were more likely to succeed at a climb if they did not enter the fear and state anxiety cognitive zones when climbing, as measured by EEG. While one study supports this in their finding that climbers who had lower state anxiety levels and higher self-confidence an hour before competing performed better than those who were more anxious (Bazancir et al., 2018), another study contradicts this, reporting that successful competition climbers had significantly *higher* levels of pre-performance somatic anxiety than unsuccessful climbers (Sanchez et al., 2010). Sanchez et al. (2010) did not find any differences for cognitive anxiety, self-confidence, or negative affect between successful and unsuccessful climbers. The latter study took place in the context

of a leading competition as opposed to bouldering, which could suggest a difference in the state required for a successful climb between these two climbing styles. Finally, Feher et al. (1998) found no significant effects of state, or trait, anxiety on climbing skill, however this survey took place outside of a competition environment, and the study quality was lower than the others.

### **Qualitative and mixed methods findings**

Heirene et al.'s (2016) high quality study reported that climbers experience withdrawal symptoms when going through periods of abstaining from climbing, with higher-ability climbers reporting more frequent and intense feelings of negative affect when unable to climb. In a fairly high quality study by Boudreau and Gibbons (2019), students in a climbing programme felt some anxiety and/or fear when climbing difficult routes, competing, or leading, which then reduced their self-efficacy: some used motivational talk to help overcome fear. In Boorman's (2008) 'Fear of Flying' training course, lead fall training was found to help reduce lead fall anxiety through desensitisation and increased confidence, however their sample size was small and generalisations should be made with caution.

### **Ongoing Trials**

Searches of CENTRAL and clinicaltrials.gov on May 2nd 2023 identified two ongoing studies relevant to this review: one investigating climbers' attitudes to injuries, mental health and body image (Sansone et al., ongoing), and the other testing a psychosocial climbing intervention for improving psychological wellbeing in adolescents in Lebanon (Luttenberger et al., ongoing).

## **Discussion**

The results of this scoping review present data from studies with a wide range of aims and designs, of varying quality, showing mixed results. Our search terms and criteria were intentionally broad in an attempt to capture studies exploring climbing and mental health and wellbeing comprehensively; yet we were surprised at the amount of literature the searches returned, indicating a growing field of investigation. Overall, the trend of evidence suggests that regardless of population (climbers or non-climbers, clinical or non-clinical, adults, children) or study design, climbing in its various forms seems to have some mental health and wellbeing benefits, with evidence from the highest quality RCTs supporting this. However, it remains unclear what mechanisms or 'active ingredients' specifically contribute to these benefits. Our results echo those of Lui et al.'s (2022) and Gassner et al.'s (2022)

reviews of therapeutic climbing, suggesting that while overall, the evidence around therapeutic benefits of climbing is positive, more high quality research is needed. Unlike the previous reviews that were restricted in their included samples, this review demonstrates the potential benefit to wellbeing for a wider range of people - not just those with physical or mental health ailments.

The results section reports findings relating to study designs and samples. It is evident from this that climbing is an activity of interest in a variety of settings, with various populations and focuses (e.g. in clinical and non-clinical populations). Our review found that studies fell into three broad groups, discussed below; 1) climbing in clinical samples, with a) mental, or b) physical health focus, 2) climbing in non-clinical samples, 3) climbing and state anxiety.

### **1a) Climbing in clinical populations with mental health conditions**

These studies included some of the highest quality research, from five RCTs delivered by one research group (Luttenberger et al., 2015; Luttenberger et al., 2022 in Germany). Their results provided encouraging evidence for using bouldering as a therapeutic intervention for clinical populations, particularly those with depression. However, these interventions were delivered as part of a well organised trial with intervention deliverers trained in both climbing and psychotherapy. Many factors could challenge the real-world implementation and on-going service delivery of their intervention, including cost and feasibility of delivery (Greenhalgh et al., 2014; Mallonee et al., 2006). Two more intervention studies involving mental health in-patients (Frühauf et al., 2021; Kleinstäuber et al., 2017) found increased positive and decreased negative affect as a result of a single climbing session. Shorter, less structured programmes may, therefore, also be beneficial for clinical populations, and are worth considering given the relative ease of implementation. However, long-term maintenance of these effects is unknown. Encouraging continuation of climbing for patients in the medium and long-term should be explored, and barriers to regular participation discussed.

### **1b) Climbing in clinical populations with physical health conditions**

While two out of eight studies reported statistically significant improvements in measures of emotional wellbeing (spinal injury - DelGrande et al., 2020; lower back pain - Engbert et al., 2011), the remaining papers involving individuals with varying health conditions (including cancer and Parkinson's Disease), reported only non-significant positive trends on mental health or wellbeing. All of these studies did not have mental health or wellbeing measures as their primary outcomes,



therefore they may not have been powered to detect significant effects on their secondary outcomes, especially given the small sample sizes. These studies, alongside Buechter and Fechtelpeter's (2011) review on the physical health benefits of climbing, indicate that the benefits of climbing are being increasingly considered for populations experiencing physical health issues. We recommend that future interventions should explicitly consider mental health, wellbeing, and QoL outcomes to capture the holistic benefit that climbing could have on various patient groups.

## **2) Climbing in non-clinical populations**

These papers report that climbing can also have positive effects on mental health, wellbeing, and/or QoL for the general (non-clinical) population. Both longer-term intensive group climbing interventions (Özen, 2018) and a one-off mindfulness and unstructured bouldering session (Wheatley, 2023) were found to improve social anxiety and/or wellbeing in university students. This suggests that climbing could be used to help protect against mental ill-health. However, it is unclear how much of the effects are due to the climbing itself or the social and/or structured aspects of sessions, and whether these effects can be maintained over a longer period. Eight studies focused on climbers' traits, reporting that climbers may have lower state anxiety than non-climbers (Robinson, 1985) and respond well under emotional stress (Tukaiev et al., 2020); however no conclusions were drawn regarding cause and effect. It is unknown whether regular participation in climbing lowers trait anxiety, or if low trait anxiety increases the likelihood for people to engage in and sustain an interest in climbing. Longitudinal, prospective cohort studies are recommended to answer this question.

## **3) Climbing and state anxiety**

This set of (mainly experimental) studies provided often contradictory findings. Climbing in some situations, in certain styles (e.g. on-sighting not redpointing) increases levels of state anxiety, which can negatively impact performance. However, Özen's (2018) study found that while anxiety levels post climbing were lower, state anxiety levels were higher during the activity. This raises the question about the potentially beneficial effects of 'in-activity' anxiety, and whether there are levels or times where anxiety is therapeutically useful. Experiencing anxiety momentarily, and then overcoming it could possibly be helpful for improving wellbeing, anxiety, and/or mental health. These studies help to explore the potential interplay between the biological and psychological effects of climbing.

### **Recently published trials**

Since our initial searches, we identified two further RCTs through CENTRAL that have now been published. These both provide further evidence for the impact of indoor climbing on mental health: specifically that climbing interventions can improve affective states, physical activity levels, quality of life, self-efficacy, and reduce state anxiety, symptoms of depression, worry, and anxiety, in out-patients with anxiety disorder and/or post-traumatic stress disorder (Bichler et al., 2022a; Bichler et al., 2022b); and that regular unstructured indoor climbing over 10 months can improve mental health in people with intellectual disabilities (Vreuls et al., 2022).

### **Strengths**

This scoping review followed a rigorous methodology in line with the Joanna Briggs Institute's protocol for scoping reviews (Aromataris & Munn, 2020), including 100% duplicate screening, data extraction, and review of study quality. The broad approach to our inclusion criteria and search terms allowed us to fully ascertain the extent of the literature, including studies investigating state anxiety during climbing experiments and competitions. These studies were unanticipated during the conception of our review, and they add another level to the literature in the field of climbing and mental health, over and above the pre-existing reviews that focused only on high quality RCTs of therapeutic climbing interventions in clinical populations.

### **Limitations of this review**

Through excluding grey literature and unpublished articles we may have missed valuable insights, however restricting to published articles was an attempt to focus on scientifically sound studies. The review was unfunded, which meant we were unable to employ translators and thus articles published outside of our languages (English, Romanian, Spanish, Italian) were excluded. It also meant within the time taken for this review to be conducted new studies may have been missed, given it is a rapidly growing field of research. However every effort has been taken to identify ongoing and recently published clinical trials, which we have reported.

### **Limitations of the included studies**

Many lacked representativeness of the population studied and the majority did not report on socioeconomic data of their participants, therefore generalisation of their findings cannot be made. Within the experimental studies in particular, small sample sizes were common, and some studies may have lacked

power to detect effects, especially where mental health measures were secondary outcomes. The quality of the studies often made data extraction difficult, with limited description of methods or intervention protocols.

### **Future research and recommendations**

The studies included in this review did not measure or test any potential mechanisms of action, which is needed to understand *why* climbing may have a positive impact on mental health and wellbeing. Researchers should develop logic models and theories of change, based on relevant theories (e.g. self-determination theory), to allow greater interrogation of ideas and assumptions. Further high quality comparisons of climbing with other forms of physical activity may help identify climbing's unique 'active ingredients'. The evidence from Karg et al.'s (2020) RCTs suggests that the positive effects of bouldering can be seen even when physical activity is controlled for. However, to what extent this was related to climbing per se, rather than the combination of structure, psychotherapy, psychoeducation, social connection, and physiological changes, is unclear. Future research could also explore how bio-psycho-social factors within climbing may interact to result in therapeutic effects. Studies could incorporate some of the experimental techniques to capture biochemical measures of anxiety within structured climbing interventions. This could aid understanding around whether short term state anxiety whilst climbing results in longer term reduction in anxiety and improvements in wellbeing.

Most of the research considered here took place in indoor climbing walls: our review excluded adventure therapy and wilderness studies where climbing was not specifically reported on, however there is a plethora of literature and interest in the benefits of exercising in green spaces (Capaldi et al., 2015). The impact of climbing outside versus indoors is worth investigating. No articles investigated the potentially negative mental health impacts of elite competition climbing. The pressure to succeed, and the potentially negative mental health effects of such are an important issue warranting investigation. Discussions on the risks and benefits of climbing at that level is required, with particular concerns around eating disorders (Joubert et al., 2020; Strand, 2022).

Future studies should describe their interventions in detail, using CONSORT (Schulz et al., 2010) and TIDieR (Hoffmann et al., 2014) guidelines where relevant, alongside any use of specific behaviour change techniques, to enable replication and comparisons across studies. Consideration of health economics, and more detailed reporting on socio-demographic data would also enable better

understanding of the generalisability of findings and feasibility of wider implementation, and highlight issues of accessibility and acceptability for all potential participants of climbing.

## **Conclusion**

These studies suggest that climbing, in various forms, may have mental health and wellbeing benefits to a wide range of people. Further high quality research is warranted to investigate exactly how, where, when, and for who climbing can improve mental health and wellbeing, and to investigate the underlying mechanisms of action to understand why it can have beneficial effects.

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## CRedit roles

- **NG:** conceptualisation, data curation, formal analysis, investigation, methodology, project administration, validation, visualisation, writing - original draft, writing - reviewing & editing.
- **AG:** conceptualisation, data curation, formal analysis, investigation, methodology, project administration, validation, visualisation, writing - original draft, writing - reviewing & editing.
- **LHH:** conceptualisation, data curation, formal analysis, investigation, methodology, project administration, validation, visualisation, writing - original draft, writing - reviewing & editing.
- **MSI:** conceptualisation, data curation, formal analysis, investigation, methodology, project administration, validation, visualisation, writing - original draft, writing - reviewing & editing.
- **HM:** data curation, investigation, validation, writing - reviewing & editing.
- **AGT:** data curation, investigation, validation, writing - reviewing & editing.

## Conflicts of Interests

LHH is the director of the charity Climb Alongside Mental Health. MSI is collaborating with Climbing Psychology developing sport psychology services for climbers, and the International Association of Psychologists in Climbing (IAPSYC) and the International Federation of Sport Climbing (IFSC) developing psychoeducation for climbers.

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Characteristics of included studies, and full searches for all databases can be found on the Open Science Framework: DOI 10.17605/OSF.IO/UDFXA

## REFERENCES

\*Included study in the review.

- \*Aras, D. İ. C. L. E., & Akalan, C. E. N. G. İ. Z. (2014). The effect of anxiety about falling on selected physiological parameters with different rope protocols in sport rock climbing. *The Journal of Sports Medicine and Physical Fitness*, 54(1), 1-8. PMID: 24445539.
- \*Aras, D., & Ewert, A. W. (2016). The effects of eight weeks sport rock climbing training on anxiety. *Acta Medica Mediterranea*, 32(1), 223–230. [https://doi.org/10.19193/0393-6384\\_2016\\_1\\_35](https://doi.org/10.19193/0393-6384_2016_1_35)
- \*Aşçı, F. H., Koca, C., Demirhan, G., & Dinç, S. C. (2006). Precompetitive anxiety and affective state of climbers in indoor climbing competition. *Perceptual and motor skills*, 102(2), 395-404. <https://doi.org/10.2466/pms.102.2.395-404>
- \*Bailey, A., Hughes, A., Bullock, K., & Hill, G. (2019). A climber's mentality: EEG analysis of climbers in action. *Journal of Outdoor Recreation, Education, and Leadership*, 11(1). <https://doi.org/10.18666/JOREL-2019-V11-I1-9268>
- \*Baláš, J., Gajdošík, J., Krupková, D., Chrastinová, L., Hlaváčková, A., Bačáková, R., & Giles, D. (2021). Psychophysiological responses to treadwall and indoor wall climbing in adult female climbers. *Scientific Reports*, 11(1), 2639. <https://doi.org/10.1038/s41598-021-82184-6>
- \*Bazancir, Z., Beydaği, M. G., & Talu, B. (2018). Effect of different pre-competition anxiety and self-confidence on the performance in bouldering climbers. *Gaziantep Üniversitesi Spor Bilimleri Dergisi*, 3(1), 1-9. <https://dergipark.org.tr/en/pub/gaunjss/issue/35918/377126>
- \*Boorman, A. (2008). Some thoughts on falling. *Innovations in Practice*, 1(1), 51-61. ISSN 1757-921X. <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=6d9596978a1ad3c5696d239c745cf07acf4687c1#page=55>
- \*Boudreau, P., & Gibbons, S. (2019). A case study of the rock climbing self-efficacy of high school students. *Physical Educator*, 76(4), 1046-1063. <https://doi.org/10.18666/TPE-2019-V76-I4-8948>
- \*Crawford, J. J., Holt, N. L., Vallance, J. K., & Courneya, K. S. (2015). Prevalence and interest in extreme/adventure activities among gynecologic cancer survivors: Associations with posttraumatic growth. *Mental Health and Physical Activity*, 9, 35-40. <https://doi.org/10.1016/j.mhpa.2015.09.001>
- \*Crawford, J. J., Vallance, J. K., Holt, N. L., Steed, H., & Courneya, K. S. (2016). A phase I/II pilot study assessing the preliminary efficacy of wall climbing for improving posttraumatic growth and quality of life in gynecologic cancer survivors. *Mental Health and Physical Activity*, 11, 60-66. <https://doi.org/10.1016/j.mhpa.2016.10.002>
- \*DelGrande, B., LaCoppola, C., Moriello, G., & Sanicola, K. (2020). Outcomes following an adaptive rock climbing program in a person with an incomplete spinal cord injury: A case report. *Physiotherapy Theory and Practice*, 36(12), 1466-1475. <https://doi.org/10.1080/09593985.2019.1587799>
- \*Dickson, T., Fryer, S., Blackwell, G., Draper, N., & Stoner, L. (2012). Effect of style of ascent on the psychophysiological demands of rock climbing in elite level climbers. *Sports Technology*, 5(3-4), 111-119. <https://doi.org/10.1080/19346182.2012.686504>
- \*Ding, C., & Schuett, M. A. (2013). Examining the motivation and involvement of Chinese rock climbers. *Journal of Outdoor Recreation, Education, and Leadership*, 5(1), 54-73. <https://doi.org/10.7768/1948-5123.1148>
- \*Draper, N., Dickson, T., Fryer, S., Blackwell, G., Winter, D., Scarrott, C., & Ellis, G. (2011). Plasma cortisol concentrations and perceived anxiety in response to on-sight rock climbing. *International journal of sports medicine*, 13-17. <https://doi.org/10.1055/s-0031-1284348>
- \*Draper, N., Jones, G. A., Fryer, S., Hodgson, C. I., & Blackwell, G. (2010). Physiological and psychological responses to lead and top rope climbing for intermediate rock climbers. *European Journal of Sport Science*, 10(1), 13-20. <https://doi.org/10.1080/17461390903108125>

- \*Draper, N., Jones, G. A., Fryer, S., Hodgson, C., & Blackwell, G. (2008). Effect of an on-sight lead on the physiological and psychological responses to rock climbing. *Journal of sports science & medicine*, 7(4), 492–498. PMID: 24149956; PMCID: PMC3761930. <https://pubmed.ncbi.nlm.nih.gov/24149956>
- \*Engbert, K., & Weber, M. (2011). The effects of therapeutic climbing in patients with chronic low back pain: a randomized controlled study. *SPINE (Phila Pa 1976)*, 36(11), 842–849. <https://doi.org/10.1097/BRS.0b013e3181e23cd1>
- \*Feher, P., Meyers, M. C., & Skelly, W. A. (1998). Psychological profile of rock climbers: state and trait attributes. *Journal of sport behavior*, 21(2), 167. <https://doi.org/10.1097/00005768-199705001-01071>
- \*Frenkel, M. O., Brokelmann, J., Nieuwenhuys, A., Heck, R. B., Kasperk, C., Stoffel, M., & Plessner, H. (2019). Mindful sensation seeking: An examination of the protective influence of selected personality traits on risk sport-specific stress. *Frontiers in psychology*, 10, 1719. <https://doi.org/10.3389/fpsyg.2019.02249>
- \*Frenkel, M. O., Heck, R. B., & Plessner, H. (2018). Cortisol and behavioral reaction of low and high sensation seekers differ in responding to a sport-specific stressor. *Anxiety, Stress, & Coping*, 31(5), 580-593. <https://doi.org/10.1080/10615806.2018.1498277>
- \*Frenkel, M. O., Laborde, S., Rummel, J., Giessing, L., Kasperk, C., Plessner, H., ... & Strahler, J. (2019). Heidelberg Risk Sport-Specific Stress Test: a paradigm to investigate the risk sport-specific psycho-physiological arousal. *Frontiers in psychology*, 10, 2249. <https://doi.org/10.3389/fpsyg.2019.02249>
- \*Frühauf, A., Heußner, J., Niedermeier, M., & Kopp, M. (2021). Expert views on therapeutic climbing—A multi-perspective, qualitative study. *International Journal of Environmental Research and Public Health*, 18(7), 3535. <https://doi.org/10.3390/ijerph18073535>
- \*Fryer, S., Dickson, T., Draper, N., Blackwell, G., & Hillier, S. (2013). A psychophysiological comparison of on-sight lead and top rope ascents in advanced rock climbers. *Scandinavian journal of medicine & science in sports*, 23(5), 645-650. <https://doi.org/10.1111/j.1600-0838.2011.01432.x>
- \*Gallotta, M. C., Emerenziani, G. P., Monteiro, M. D., Iasevoli, L., Iazzoni, S., Baldari, C., & Guidetti, L. (2015). Psychophysical benefits of rock-climbing activity. *Perceptual and motor skills*, 121(3), 675-689. <https://doi.org/10.2466/30.PMS.121c26x9>
- \*Gassner, L., Dabnichki, P., Langer, A., Pokan, R., Zach, H., Ludwig, M., & Santer, A. (2022). The Therapeutic Effects of Climbing: A Systematic Review and Meta-Analysis. *PM&R*. <https://doi.org/10.1002/pmrj.12891>
- \*Green, A. L., Draper, N., & Helton, W. S. (2014). The impact of fear words in a secondary task on complex motor performance: a dual-task climbing study. *Psychological research*, 78, 557-565. <https://doi.org/10.1007/s00426-013-0506-8>
- Hall, L. H., Gude, A., Gridley, N., & Ionel, M. S. (2021, June 30). The associations between climbing and mental health: A scoping review protocol: <https://doi.org/10.17605/OSF.IO/UDFXA>
- \*Hardy, L., & Hutchinson, A. (2007). Effects of performance anxiety on effort and performance in rock climbing: A test of processing efficiency theory. *Anxiety, stress, and coping*, 20(2), 147-161. <https://doi.org/10.1080/10615800701217035>
- \*Hardy, L., & Whitehead, R. (1984). Specific modes of anxiety and arousal. *Current psychological research & reviews*, 3, 14-24. <https://doi.org/10.1007/BF02686520>
- \*Heirene, R. M., Shearer, D., Roderique-Davies, G., & Mellalieu, S. D. (2016). Addiction in extreme sports: An exploration of withdrawal states in rock climbers. *Journal of behavioral addictions*, 5(2), 332-341. <https://doi.org/10.1556/2006.5.2016.039>
- \*Hodgson, C. I., Draper, N., McMorris, T., Jones, G., Fryer, S., & Coleman, I. (2009). Perceived anxiety and plasma cortisol concentrations following rock climbing with differing safety rope protocols. *British Journal of Sports Medicine*, 43(7), 531-535. <http://dx.doi.org/10.1136/bjism.2007.046011>



- \*Hrušová, D., & Chaloupská, P. (2019). Experiencing In Climbing And Psychological Effects Of Sport Climbing. In S. Ivanova, & I. Elkina (Eds.), *Cognitive - Social, and Behavioural Sciences - icCSBs 2018*, vol 56. *European Proceedings of Social and Behavioural Sciences* (pp. 118-126). Future Academy.  
<https://doi.org/10.15405/epsbs.2019.02.02.14>
- \*Jones, M. V., Mace, R. D., Bray, S. R., MacRae, A. W., & Stockbridge, C. (2002). The impact of motivational imagery on the emotional state and self-efficacy levels of novice climbers. *Journal of Sport Behavior*, 25(1), 57-73. <https://psycnet.apa.org/record/2002-00861-004>
- \*Karg, N., Dorscht, L., Kornhuber, J., & Luttenberger, K. (2020). Bouldering psychotherapy is more effective in the treatment of depression than physical exercise alone: results of a multicentre randomised controlled intervention study. *BMC psychiatry*, 20, 1-13. <https://doi.org/10.1186/s12888-020-02518-y>
- \*Kessell, M. J. (1994). Women's adventure group: Experiential therapy in an HMO setting. *Women & therapy*, 15(3-4), 185-203. [https://doi.org/10.1300/J015v15n03\\_15](https://doi.org/10.1300/J015v15n03_15)
- \*Kleinstäuber, M., Reuter, M., Doll, N., & Fallgatter, A. J. (2017). Rock climbing and acute emotion regulation in patients with major depressive disorder in the context of a psychological inpatient treatment: a controlled pilot trial. *Psychology research and behavior management*, 10, 277. <https://doi.org/10.2147/PRBM.S143830>
- \*Limonta, E., Fanchini, M., Rampichini, S., Cé, E., Longo, S., Coratella, G., & Esposito, F. (2020). On-sight and red-point climbing: Changes in performance and route-finding ability in male advanced climbers. *Frontiers in Psychology*, 11, 902. <https://doi.org/10.3389/fpsyg.2020.00902>
- \*Luttenberger, K., Karg- Hefner, N., Berking, M., Kind, L., Weiss, M., Kornhuber, J., & Dorscht, L. (2022). Bouldering psychotherapy is not inferior to cognitive behavioural therapy in the group treatment of depression: A randomized controlled trial. *British Journal of Clinical Psychology*, 61(2), 465-493. <https://doi.org/10.1111/bjc.12347>
- \*Luttenberger, K., Stelzer, E. M., Först, S., Schopper, M., Kornhuber, J., & Book, S. (2015). Indoor rock climbing (bouldering) as a new treatment for depression: study design of a waitlist-controlled randomized group pilot study and the first results. *BMC psychiatry*, 15(1), 1-10. <https://doi.org/10.1186/s12888-015-0585-8>
- \*Madeira, L. P., Borghi, F., Wilson, V. D., Souza, A. L., Pires- da- Rocha, M. C., Ferreira, H. A., ... & Schwartz, G. M. (2019). Perceived stress and salivary cortisol on rock climbing. *Translational Sports Medicine*, 2(6), 370-375. <https://doi.org/10.1002/tsm2.104>
- \*Magiera, A., Łukasik, I., Rocznik, R., & Placek, O. (2019). The effects of change in the safety rope protocol, hold size, and rest period on psychophysiological responses in sport rock climbers. *Human Movement*, 20(2), 34-43. <https://doi.org/10.5114/hm.2019.79733>
- \*Maynard, I.W., MacDonald, A.L. and Warwick-Evans, L.A. (1997) Anxiety in novice rock climbers: a further test of the matching hypothesis in a field setting. *International Journal of Sports Psychology*, 28(1), 67-78. <http://eprints.soton.ac.uk/id/eprint/18434>
- \*Nieuwenhuys, A., Pijpers, J. R., Oudejans, R. R., & Bakker, F. C. (2008). The influence of anxiety on visual attention in climbing. *Journal of Sport and Exercise Psychology*, 30(2), 171-185. <https://doi.org/10.1123/jsep.30.2.171>
- \*Özen, G. (2015). The effect of climbing community activities as a leisure on university students' social anxiety. *The Anthropologist*, 21(3), 558-564. <https://doi.org/10.1080/09720073.2015.11891847>
- \*Özen, G. (2018). The effect of recreational activities on trait and state anxiety levels. *International Journal Research - Granthaalayah*, 18, 60-65. <https://doi.org/10.5281/zenodo.1133568>

- \*Pijpers, J. R., Oudejans, R. R., & Bakker, F. C. (2005). Anxiety-induced changes in movement behaviour during the execution of a complex whole-body task. *The Quarterly Journal of Experimental Psychology Section A*, *58*(3), 421-445. <https://doi.org/10.1080/02724980343000945>
- \*Pijpers, J. R., Oudejans, R. R., Bakker, F. C., & Beek, P. J. (2006). The role of anxiety in perceiving and realizing affordances. *Ecological psychology*, *18*(3), 131-161. [https://doi.org/10.1207/s15326969eco1803\\_1](https://doi.org/10.1207/s15326969eco1803_1)
- \*Pijpers, J. R., Oudejans, R. R., Holsheimer, F., & Bakker, F. C. (2003). Anxiety–performance relationships in climbing: a process-oriented approach. *Psychology of sport and exercise*, *4*(3), 283-304. [https://doi.org/10.1016/S1469-0292\(02\)00010-9](https://doi.org/10.1016/S1469-0292(02)00010-9)
- \*Robinson, D. W. (1985). Stress seeking: Selected behavioral characteristics of elite rock climbers. *Journal of Sport and Exercise Psychology*, *7*(4), 400-404. <https://doi.org/10.1123/jsp.7.4.400>
- \*Sanchez, X., Boschker, M. S. J., & Llewellyn, D. J. (2010). Pre- performance psychological states and performance in an elite climbing competition. *Scandinavian journal of medicine & science in sports*, *20*(2), 356-363. <https://doi.org/10.1111/j.1600-0838.2009.00904.x>
- \*Schram Christensen, M., Jensen, T., Voigt, C. B., Nielsen, J. B., & Lorentzen, J. (2017). To be active through indoor-climbing: an exploratory feasibility study in a group of children with cerebral palsy and typically developing children. *BMC neurology*, *17*(1), 1-20. <https://doi.org/10.1186/s12883-017-0889-z>
- \*Schroeder, C., Barnes, R. F., Volland, L., Nguyen, S., & von Drygalski, A. (2018). Effects of top rope climbing therapy on joint health in adult haemophilia patients with severe arthropathies. *The Journal of Haemophilia Practice*, *5*(1), 93-102. <https://doi.org/10.17225/jhp00115>
- \*Schwarz, L., Dorscht, L., Book, S., Stelzer, E. M., Kornhuber, J., & Luttenberger, K. (2019). Long-term effects of bouldering psychotherapy on depression: benefits can be maintained across a 12-month follow-up. *Heliyon*, *5*(12). <https://doi.org/10.1016/j.heliyon.2019.e02929>
- \*Stelzer, E. M., Book, S., Graessel, E., Hofner, B., Kornhuber, J., & Luttenberger, K. (2018). Bouldering psychotherapy reduces depressive symptoms even when general physical activity is controlled for: A randomized controlled trial. *Heliyon*, *4*(3), 1-25. <https://doi.org/10.1016/j.heliyon.2018.e00580>
- \*Stemberger, M., Schmit, E., Kurnik, K., & Spannagl, M. (2015). Motivational effects of top- rope climbing therapy under individualized prophylaxis: a pilot study in young adults with severe haemophilia. *Haemophilia*, *21*(6), e504-e507. <https://doi.org/10.1111/hae.12773>
- \*Tukaiev, S., Dolgova, O., Van Den Tol, A. J. M., Ruzhenkova, A., Lysenko, O., Fedorchuk, S., ... & Voronova, V. (2020). Individual psychological determinants of stress resistance in rock climbers. *Journal of Physical Education and Sport*, *20*(Suppl1), 469-476. <https://doi.org/10.7752/jpes.2020.s1069>
- \*Velikonja, O., Čurić, K., Ožura, A., & Jazbec, S. Š. (2010). Influence of sports climbing and yoga on spasticity, cognitive function, mood and fatigue in patients with multiple sclerosis. *Clinical neurology and neurosurgery*, *112*(7), 597-601. <https://doi.org/10.1016/j.clineuro.2010.03.006>
- \*Villavicencio, P., Bravo, C., Ibarz, A., & Solé, S. (2021). Effects of acute psychological and physiological stress on rock climbers. *Journal of clinical medicine*, *10*(21), 5013. <https://doi.org/10.3390/jcm10215013>
- \*Wheatley, K. A. (2023). Exploring the relationship between mindfulness and rock-climbing: a controlled study. *Current Psychology*, *42*(4), 2680-2692. <https://doi.org/10.1007/s12144-021-01593-y>
- Ardahan, F., & Mert, M. (2013). Impacts of outdoor activities, demographic variables and emotional intelligence on life satisfaction: An econometric application of a case in Turkey. *Social Indicators Research*, *113*(3), 887-901. <https://doi.org/10.1007/s11205-012-0118-5>
- Aromataris, E., Munn, Z. (2020). *JBI Manual for Evidence Synthesis*. <https://doi.org/10.46658/JBIMES-20-01>

- Bichler, C. S., Niedermeier, M., Hübner, K., Gálffy, M., Gostner, J. M., Nelles, P., ... & Kopp, M. (2022a). Climbing as an add-on treatment option for patients with severe anxiety disorders and PTSD: feasibility analysis and first results of a randomized controlled longitudinal clinical pilot trial. *International journal of environmental research and public health*, 19(18), 11622. <https://doi.org/10.3390/ijerph191811622>
- Bichler, C., Niedermeier, M., Hübner, K., Gálffy, M., Sperner-Unterweger, B., & Kopp, M. (2022b). Affective responses to both climbing and nordic walking exercise are associated with intermediate-term increases in physical activity in patients with anxiety and posttraumatic stress disorder – a randomized longitudinal controlled clinical pilot trial. *Journal of Psychosomatic Research*, 157, 110828. <https://doi.org/10.1016/j.jpsychores.2022.110828>
- British Mountaineering Council. (2016) *Why climbing benefits mental wellbeing*. British Mountaineering Council (BMC). <https://www.thebmc.co.uk/benefits-of-climbing-on-mental-wellbeing>
- British Mountaineering Council. (2017) *How to harness positive mental wellbeing by rock climbing*. British Mountaineering Council (BMC). <https://www.thebmc.co.uk/Positive-mental-wellbeing-through-rock-climbing>.
- Buechter, R. B., & Fechtelpeter, D. (2011). Climbing for preventing and treating health problems: a systematic review of randomized controlled trials. *GMS German Medical Science*, 9. <https://doi.org/10.3205%2F000142>
- Capaldi, C. A., Passmore, H. A., Nisbet, E. K., Zelenski, J. M., & Dopko, R. L. (2015). Flourishing in nature: A review of the benefits of connecting with nature and its application as a wellbeing intervention. *International Journal of Wellbeing*, 5(4). <https://doi.org/10.5502/ijw.v5i4.449>
- Chan, S.F., La Greca, A.M. (2013). Perceived Stress Scale (PSS). In: Gellman, M.D., Turner, J.R. (eds) *Encyclopedia of Behavioral Medicine*. Springer, New York, NY. [https://doi.org/10.1007/978-1-4419-1005-9\\_773](https://doi.org/10.1007/978-1-4419-1005-9_773)
- Cox, R. H., Martens, M. P., & Russell, W. D. (2003). Measuring anxiety in athletics: the revised competitive state anxiety inventory–2. *Journal of sport and exercise psychology*, 25(4), 519-533. <https://doi.org/10.1123/jsep.25.4.519>
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum.
- Diener, E., Wirtz, D., Tov, W., Kim-Prieto, C., Choi, D., Oishi, S., & Biswas-Diener, R. (2010). New measures of well-being: Flourishing and positive and negative feelings. In: Diener, E. (Ed.) *Assessing well-being*. Social Indicators Research Series, vol 39 (pp. 247-266). Springer, Dordrecht. [https://doi.org/10.1007/978-90-481-2354-4\\_12](https://doi.org/10.1007/978-90-481-2354-4_12)
- Draper, N., Giles, D., Schöffel, V., Konstantin Fuss, F., Watts, P., Wolf, P., Baláš, J., Espana-Romero, V., Blunt Gonzalez, G., Fryer, S., Fanchini, M., Vigouroux, L., Seifert, L., Donath, L., Spoerri, M., Bonetti, K., Phillips, K., Stöcker, U., Bourassa-Moreau, F., ... Abreu, E. (2015). Comparative grading scales, statistical analyses, climber descriptors and ability grouping: International Rock Climbing Research Association position statement. *Sports Technology*, 8(3–4), 88–94. <https://doi.org/10.1080/19346182.2015.1107081>
- Enkema, M. C., McClain, L., Bird, E. R., Halvorson, M. A., & Larimer, M. E. (2020). Associations between mindfulness and mental health outcomes: A systematic review of ecological momentary assessment research. *Mindfulness*, 11, 2455-2469. <https://doi.org/10.1007/s12671-020-01442-2>
- Greenhalgh, T., Howick, J., & Maskrey, N. (2014). Evidence based medicine: a movement in crisis?. *BMJ*, 348, 1-7. <https://doi.org/10.1136/bmj.g3725>
- Hoffmann, T. C., Glasziou, P. P., Boutron, I., Milne, R., Perera, R., Moher, D., ... & Michie, S. (2014). Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ*, 348. <https://doi.org/10.1136/bmj.g1687>

- Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., ... & Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for information, 34*(4), 285-291. <https://doi.org/10.3233/EFI-180221>
- IBISWorld. (2021). Indoor climbing walls industry in the US – market research report. <https://www.ibisworld.com/united-states/market-research-reports/indoor-climbing-walls-industry/>
- Institute for Climbing Therapy. (2021). <https://www.climbingtherapy.com/>
- John Hopkins Medicine (2022). *Mental health statistics*. <https://www.hopkinsmedicine.org/health/wellness-and-prevention/mental-health-disorder-statistics>
- Joubert, L. M., Gonzalez, G. B., & Larson, A. J. (2020). Prevalence of disordered eating among international sport lead rock climbers. *Frontiers in sports and active living, 2*, 86. <https://doi.org/10.3389/fspor.2020.00086>
- Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: a new depression diagnostic and severity measure. *Psychiatric annals, 32*(9), 509-515. <https://doi.org/10.3928/0048-5713-20020901-06>
- Liu, S., Gong, X., Li, H., & Li, Y. (2022). The Origin, Application and Mechanism of Therapeutic Climbing: A Narrative Review. *International Journal of Environmental Research and Public Health, 19*(15), 9696. <https://doi.org/10.3390/ijerph19159696>
- Lorite, J., Serrano, F., Lorenzo, A., Canadas, E. M., Ballesteros, M., & Peñas, J. (2017). Rock climbing alters plant species composition, cover, and richness in Mediterranean limestone cliffs. *PLoS One, 12*(8), e0182414. <https://doi.org/10.1371/journal.pone.0182414>
- Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., ... & Biddle, S. (2016). Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics, 138*(3). <https://doi.org/10.1542/peds.2016-1642>
- Luttenberger, K., Najem, C., Rosenbaum, S., Sifri, C., Kind, L., & Baggenstos, B. (ongoing). A Climbing (Bouldering) Intervention to Increase the Psychological Well-Being of Adolescents in the Bekaa Valley in Lebanon-Study Protocol for a Controlled Trial. *International Journal of Environmental Research and Public Health, 20*(5), 4289. <https://doi.org/10.3390/ijerph20054289>
- Mallonee, S., Fowler, C., & Istre, G. R. (2006). Bridging the gap between research and practice: a continuing challenge. *Injury prevention, 12*(6), 357-359. <http://dx.doi.org/10.1136/ip.2006.014159>
- National Institute for Health and Care Excellence. (2013) *Physical activity: brief advice for adults in primary care*, in *Public health guideline*. NICE guideline. <https://www.nice.org.uk/guidance/ph44>
- National Institute for Health and Care Excellence. (2022). *Depression in adults: treatment and management*. NICE guideline. <https://www.nice.org.uk/guidance/ng222>
- NHS. (2020). *Climbing*. <https://www.nhsinform.scot/healthy-living/keeping-active/activities/climbing>
- Paluska, S. A., & Schwenk, T. L. (2000). Physical activity and mental health. *Sports medicine, 29*(3), 167-180. <https://doi.org/10.2165/00007256-200029030-00003>
- Rabin, R., & Charro, F. D. (2001). EQ-SD: a measure of health status from the EuroQol Group. *Annals of medicine, 33*(5), 337-343. <https://doi.org/10.3109/07853890109002087>
- Rebar, A. L., & Taylor, A. (2017). Physical activity and mental health; it is more than just a prescription. *Mental Health and Physical Activity, 13*, 77-82. <https://doi.org/10.1016/j.mhpa.2017.10.004>
- Richardson, C. R., Faulkner, G., McDevitt, J., Skrinar, G. S., Hutchinson, D. S., & Piette, J. D. (2005). Integrating physical activity into mental health services for persons with serious mental illness. *Psychiatric services, 56*(3), 324-331. <https://doi.org/10.1176/appi.ps.56.3.324>

- Schulz, K. F., Altman, D. G., & Moher, D. (2010). CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *Journal of Pharmacology and pharmacotherapeutics*, 1(2), 100-107. <https://doi.org/10.4103/0976-500X.72352>
- Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.
- Strand, M. (2022). Attitudes towards disordered eating in the rock climbing community: a digital ethnography. *Journal of Eating Disorders*, 10(1), 96. <https://doi.org/10.1186/s40337-022-00619-5>
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., ... & Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Annals of internal medicine*, 169(7), 467-473. <https://doi.org/10.7326/M18-0850>
- UKC (2017). *Men, Masculinities and Mental Health*. UKClimbing Limited. [https://www.ukclimbing.com/articles/features/men\\_masculinities\\_and\\_mental\\_health-9530](https://www.ukclimbing.com/articles/features/men_masculinities_and_mental_health-9530).
- Vreuls, R. J. A., Mockenhaupt, J., Tillmann, V., & Anneken, V. (2022). Effect of indoor climbing on occupational self-efficacy and employability: results of a 10-month randomised controlled study of persons with intellectual disability. *International journal of environmental research and public health*, 19(20), 13399. <https://doi.org/10.3390/ijerph192013399>
- Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of personality and social psychology*, 54(6), 1063. <https://doi.org/10.1037/0022-3514.54.6.1063>
- White, R. L., Babic, M. J., Parker, P. D., Lubans, D. R., Astell-Burt, T., & Lonsdale, C. (2017). Domain-specific physical activity and mental health: a meta-analysis. *American journal of preventive medicine*, 52(5), 653-666. <https://doi.org/10.1176/appi.ps.56.3.324>
- World Health Organisation (2004). *Promoting mental health: concepts, emerging evidence, practice (Summary report)*. World Health Organization.
- World Health Organisation (2019a). *Mental disorders*. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/mental-disorders>
- World Health Organisation (2019b). *Motion for your mind: Physical activity for mental health promotion, protection and care*. World Health Organization. <https://apps.who.int/iris/handle/10665/346405>
- World Health Organisation (2020). *Physical activity*. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/physical-activity>
- World Health Organisation (2021). *Mental Health*. World Health Organization. [https://www.who.int/health-topics/mental-health - tab=tab\\_1](https://www.who.int/health-topics/mental-health - tab=tab_1)
- World Health Organisation (2022). COVID-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide. Wake-up call to all countries to step up mental health services and support. World Health Organization. <https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-prevalence-of-anxiety-and-depression-worldwide>
- Young, P. R., & Knight, E. L. (2014). Use of psychological skills by risk sport athletes. *Journal of Human Performance in Extreme Environments*, 11(2), 2. <http://dx.doi.org/10.7771/2327-2937.1061>
- Zieliński, G., Byś, A., Baszczowski, M., Ginszt, M., Suwała, M., & Majcher, P. (2018). The influence of sport climbing on depression and anxiety levels-literature review. *Journal of Education, Health and Sport*, 8(7), 336-344. <http://dx.doi.org/10.5281/zenodo.1318229>

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta psychiatrica scandinavica*, 67(6), 361-370. <https://doi.org/10.1111/j.1600-0447.1983.tb09716.x>

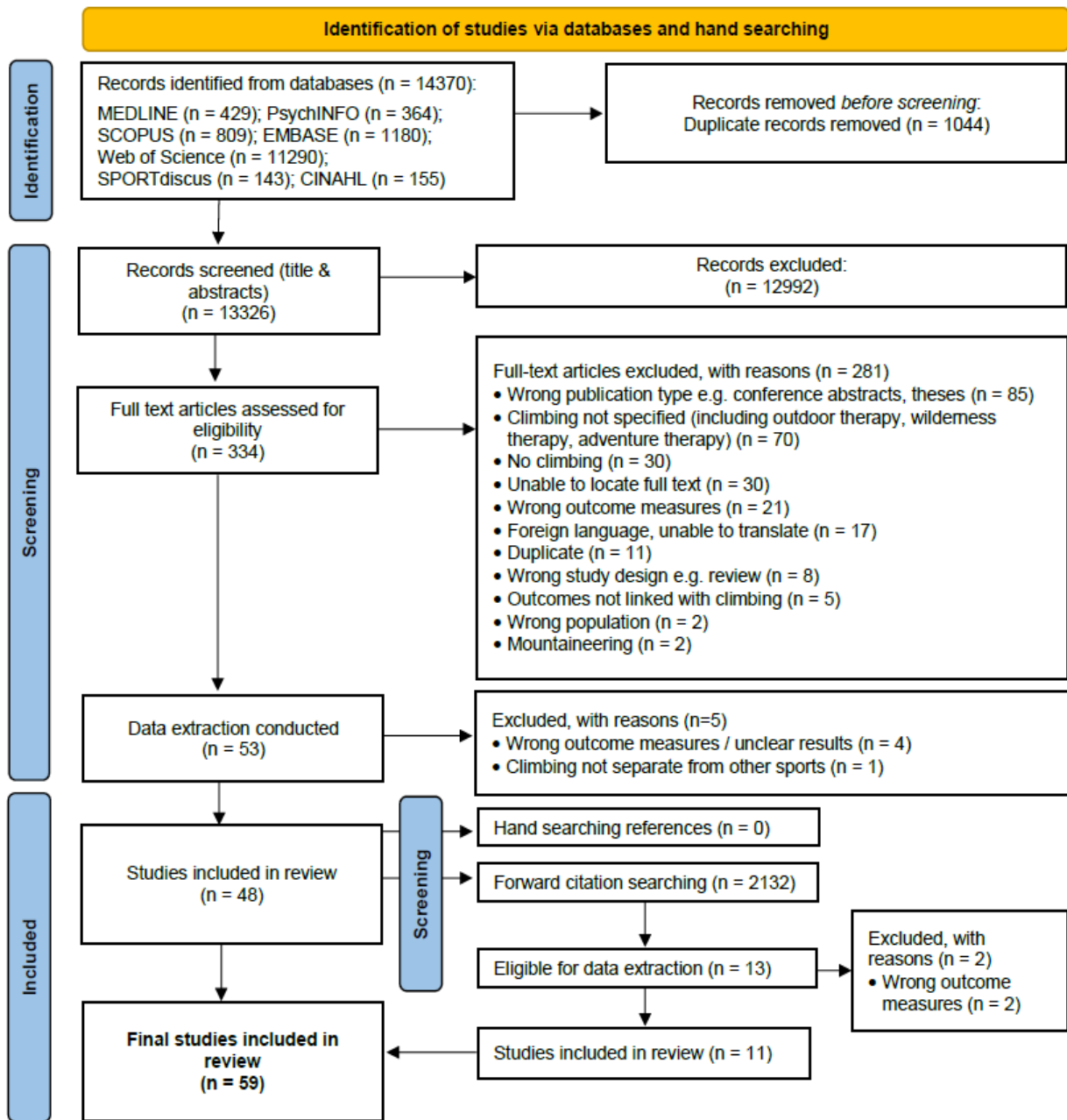


Fig. 1: PRISMA flow diagram of study selection.

**Table 1***Summary of findings from therapeutic climbing interventions (n = 20)*

Sample	Findings	Intervention	Study Design	Study	Quality
<b><i>Clinical: Mental Health Conditions, Adults</i></b>					
Depression: Out-patients	Reduced depression (by one severity grade). Improved anxiety, body image, global self-esteem.	10 week Bouldering Psychotherapy (BPT) group; Weekly sessions	RCT	Karg et al., 2020	4/5
	Reduced depression (by one severity grade). Improved anxiety, body image, global self-esteem.	10 week BPT; Weekly sessions	RCT	Luttenberger et al., 2022	5/5
	Reduced depression (even when controlling for physical activity, psychotherapy, antidepressants).	8 week BPT; Weekly sessions	RCT	Stelzer et al., 2018	4/5
	Reduced depression (by one severity grade).	8 week BPT; Weekly sessions	RCT	Luttenberger et al., 2015	4/5
	Reduced depression at 8 weeks and 12 months follow up.	8 week BPT; Weekly sessions (Combined Luttenberger et al.'s 2015 and Stelzer et al.'s 2018 samples)	RCT	Schwarz et al., 2019	4/5
Depression: In-patients	Decreased negative affect and depressiveness. Increased positive affect and coping emotions.	One-off group session, roped climbing, post- climb reflections	Non-RCT	Kleinstäuber et al., 2017	3/5
<b><i>Clinical: Physical Health Conditions, Adults</i></b>					
Parkinson's Disease	Improved mood for some but not all. Improved fatigue, body awareness, physical wellbeing in majority. Enjoyed it.	4 week Therapeutic Climbing; 3-5 group sessions a week, alongside additional physiotherapies	Feasibility trial	Gassner et al., 2022	3/5
Chronic Lower Back Pain	Improved mental health, vitality, and social functioning.	4 week Therapeutic Climbing; 4 sessions a week	RCT	Engbert et al., 2011	2/5
Gynaecological Cancer Patients	Non-sig improvement on mental health.	8 Weeks; 2 group sessions per week; bouldering and roped	Pilot RCT	Crawford et al., 2016	3/5
Incomplete spinal cord injury	Improved Quality of Life (from 'good' to 'excellent').	19 week roped climbing; 2 sessions a week	Case Study $n=1$	DelGrande et al., 2020	4/5



Sample	Findings	Intervention	Study Design	Study	Quality
Patients with Haemophilia	QoL remained high (no change). It was safe.	3 months top-roping; Weekly sessions.	Pilot Study	Schroeder et al., 2018	2/5
	Improved QoL and depression in some (not all) patients. It was safe.	8.5 months top-roping; Weekly sessions. Plus a 3 day outdoor climbing (and other activities) camp.	Non-RCT	Stemberger et al., 2015	4/5
Multiple Sclerosis	Non-sig decrease in depression. No change in mood. Improvements on fatigue.	10 weeks top-roping; Weekly sessions	RCT	Velikonja et al., 2010	5/5
<b>Non-clinical: Adults</b>					
General population	Decreased state anxiety. No change in mood.	3 months; Twice weekly sessions	Between groups randomised	Gallotta et al., 2015	2/5
University Students	Decreased anxiety (decreased somatic and cognitive; improved self-confidence).	8 weeks; 3 session a week; top-roping	Non-RCT	Aras et al., 2016	2/5
	Decreased social anxiety.	8 weeks; 3 group sessions per week; indoors & outdoors	Within subjects 'quasi-experimental'	Özen et al., 2015	4/5
	Increased state anxiety during climbing. No effect on trait anxiety.	'Climbing'	Within subjects	Özen et al., 2018	2/5
	Increase in wellbeing and mindfulness.	One-off session: mindfulness followed by unstructured bouldering	Between groups 'quasi-experimental'	Wheatley et al., 2023	5/5
<b>Clinical: Children</b>					
Cerebral Palsy	Non-sig. increase in mental health.	9 days of climbing over 17 day period; groups; bouldering and top-rope	Non-RCT feasibility	Schram Christensen et al., 2017	3/5
Mental Health Diagnosis: In-patients	Increased positive affect, decreased negative affect.	One-off group roped and bouldering session	Cross-over design	Frühauf et al., 2021	2/5

*BPT = Bouldering Psychotherapy; RCT = Randomised Controlled Trial; QoL = Quality of Life*

**Table 2***Summary of findings from experimental studies (n = 25)*

<b>Manipulations</b>	<b>Findings</b>	<b>Studies</b>	<b>Quality</b>
<b><i>Climbers: Non-clinical</i></b>			
Lead vs. top-roping	Lead = Higher pre & post climb anxiety, Lower self-confidence	Aras et al., 2014; Hardy et al., 2007b Hodgson et al., 2009; Magiera et al., 2019	2/5 2/5 4/5 2/5
	No difference in state anxiety	Dickson et al., 2012; Draper et al., 2010; Draper et al., 2011	3/5 2/5 3/5
Speed vs. standard top-roping during a competition	No difference in state anxiety	Aşçi et al., 2006	1/5
Top-roping vs. treadwall	No difference in state anxiety	Baláš et al., 2012	3/5
On-sighting vs. red-pointing (indoors; outdoors; lead and top-roping)	On-sight = Higher pre-climb state anxiety	Draper et al., 2008	2/5
		Hardy et al., 2007c	2/5
		Limonta et al., 2020	4/5
Lead on-sight vs. top-rope on-sight	No difference in state anxiety	Fryer et al., 2013	2/5
Outdoor lead on-sight vs. lead flash	No difference in state anxiety	Madeira et al., 2019	4/5
Difficult climb (lead or top-rope) vs. easy climb (lead or top-rope)	Difficult = higher pre-climb anxiety	Hardy et al., 2007a	2/5
Leading at varying difficulties vs. bouldering vs. non-climbing	All climbing days = higher anxiety	Hardy et al., 1984	3/5
Climbing + memorising words vs. climbing	Memorising words = higher anxiety	Green et al., 2014	2/5
Climbing + loud noise vs. climbing	Loud noise = higher anxiety	Villavicencio et al., 2021	2/5
<b><i>Non-Climbers: Non-clinical</i></b>			
High-level vs. low-level traversing	High-level = Higher anxiety (before & after)	Nieuwenhuys et al., 2008; Pijpers et al., 2003; Pijpers et al., 2005; Pijpers et al., 2006	4/5 4/5 5/5 5/5
Visualisation before climbing	Reduce perceived stress	Jones et al., 2002	3/5
Somatic relaxation training	Reduced cognitive anxiety	Maynard et al., 1997	1/5
HRSST / 'climb to top of wall and jump into the rope'	Increased state anxiety	Frenkel et al., 2018; Frenkel, Brokelmann et al., 2019; Frenkel, Laborde et al., 2019	4/5 0/5 2/5

**Table 3.** Summary of findings from descriptive studies (n = 11)

Sample	Findings	Design	Study	Quality
<b>Climbers: All Non-clinical</b>				
Varying levels	Main motivation for climbing = to 'escape' (releasing tension, resting the mind, tranquillity). Social aspect explained the least variance in motivations for climbing.	Survey	Ding et al., 2013	3/5
Advanced and moderate level climbers	No difference in state or trait anxiety between level of climber, or genders.	Survey	Feher et al., 1998	2/5
Elite level climbers	Climbers had significantly lower trait anxiety compared to normative data for male students.	Survey	Robinson et al., 1985	3/5
<b>Competition Setting:</b> IFSC finals (Elite level climbers)	Successful climbers reported significantly higher levels of pre-performance somatic anxiety than unsuccessful climbers. No differences for cognitive anxiety, negative affect, or self-confidence.	Between groups survey	Sanchez et al., 2010	5/5
Bouldering competition	Climbers with lower pre-climb anxiety and higher self-confidence performed better. No correlation between trait anxiety and performance.	Surveys	Bazancir et al., 2018	4/5
Bouldering competition	Successful climbers spent more time in high motivation, high inward attention zones than the fear and anxiety zones.	Observational: EEG data	Bailey et al., 2019	3/5
<b>Climbers vs. non-climbers: All Non-clinical</b>				
General population: rock climbers (and mountaineers, trekkers, and cyclists) vs. non-participants of the outdoors	Rock climbers had higher life satisfaction than those who do not participate in the outdoors, and than cyclists. Not higher than trekkers.	Between groups survey	Ardahan et al., 2013	1/5
Climbers v. Sporty University Students	Climbers can respond well under emotional stress (high neuropsychological stress resistance).	Between groups survey	Tukaiev et al., 2020	5/5
<b>Non-climbers</b>				
<b>Non-clinical:</b> University students attended a 3month indoor climbing course	Increase in psychological wellbeing. Decrease in impulsiveness, discomfort and restlessness, fears and anxious expectations, sadness. No change in depression and exhaustion.	'Quasi-experimental' pre-post survey	Hrušová et al., 2019	1/5
<b>Clinical: Physical Health Condition:</b> Gynaecological cancer survivors	Participation, or interest in participating in climbing was not associated with post-traumatic growth.	Survey	Crawford et al., 2015	3/5
<b>Clinical: Mental Health Condition:</b> Variety diagnoses e.g., major depression, PTSD	Reported improvements in self-esteem, feeling isolated, self-confidence, overcoming fear, and reducing anxiety.	Survey	Kessell et al., 1994	0/5