Abstract

There is increasing interest in the potential efficacy of meditation-based mind-body interventions (MBIs) within mental health care. We conducted a systematic meta-review of the published randomized control trial (RCT) evidence. MEDLINE/PubMed, PsycARTICLES and EMBASE were searched from inception to 06/2020 examining MBIs (mindfulness, qigong, tai chi, yoga) as add-on or monotherapy versus no treatment, minimal treatment and passive and active control conditions in people with a mental disorder. The quality of the methods of the included meta-analyses using A Measurement Tool to Assess Systematic Reviews (AMSTAR) and the methodological quality of the RCTs using AMSTAR-Plus. Sixteen (94%) of 17 meta-analyses had good overall methodological quality. The content validity of the included RCTs was considered good in 9 (53%) meta-analyses. In meta-analyses with good methodological quality (AMSTAR 8≤) and content validity (AMSTAR+ 4≤), large effect sizes (0.80 or higher) were observed for mindfulness in schizophrenia and in ADHD, a moderate (0.50≤0.80) effect size for mindfulness in PTSD and a small (0.20<0.50) effect size for yoga in schizophrenia No serious adverse events were reported (n RCTs =43, n in the MBI arms=1774), while the attrition rates were comparable with the rates in passive and active control conditions. Our meta-review demonstrates that mindfulness and to a lesser extent yoga may serve as an efficacious supplement to pharmacotherapy, and psychotherapy and can be complementary in healthy lifestyle interventions for people with mental disorders. Meta-analytic evidence of high methodological quality and content validity of included trials is currently lacking for qigong and tai chi.

Key words: ADHD; depression; mindfulness; qigong; schizophrenia; tai chi; yoga

1. Introduction

In recent years there has been a renewed optimism towards recovery in people with mental disorders (Ozonoff, 2013; Vita and Barlati, 2018). However, the long-term treatment effects are being questioned (Cortese et al., 2018). For example, for many people with mental disorders, psychotropic medication does not result in clinically meaningful improvement in the long-term and the side-effects are considerable (De Hert et al., 2012; Vancampfort et al., 2015). These side-effects often result in medication discontinuation and distress and can negatively impact patients' life (Ashoorian et al., 2015; Ostrow et al., 2017; Wykes et al., 2017). The renewed optimism therefore mainly comes from the increasing evidence for non-pharmacological interventions, and in particular from modifying the unhealthy lifestyles that may be common in people with a mental disorder (Ashdown-Franks et al., 2019; Gee et al., 2019; Teasdale et al., 2017; Vancampfort et al., 2019). Lifestyle interventions are therefore increasingly being considered as an important component of treatment. For example, physical activity (PA) is now acknowledged as an effective first-line or adjunctive treatment for improving mental and physical symptoms across a broad range of mental disorders (Ashdown-Franks et al., 2019; Firth et al., 2020).

Within lifestyle interventions for people with a mental disorder, there is growing interest in mind-body interventions as an adjunctive treatment for mental disorders. For instance, 26% of those with depression and 34% of those with anxiety spectrum disorders in the US reported using meditation-based mind-body interventions (MBIs) in the management of their condition (Wolsko et al., 2003). Mind-body complementary health approaches are a diverse group of health care practices focused on the relationships between the mind, body, brain, and behaviour that are not currently considered a part of conventional medicine (Gellis, 2017). While there are many mind-body therapy approaches (Gellis, 2017), in this meta-review we will focus on the MBIs mindfulness, qigong, tai chi, and yoga. These are characterized by incorporating exercises including controlled physical movements, full-body stretching, breathing techniques, and a meditation component. The meditation component mainly consists of basic training of internal concentration by focusing the body and/or breathing, and leads to an altered dynamic of consciousness. Meditation practice is essentially a practice of awareness and all the considered interventions share fundamental meditation exercises such as sited meditation or body-scans (Sabe et al., 2019). All these MBIs require active involvement from the participant, are popular in the general population, often integrated in multidisciplinary mental health programs, and have great potential for

dissemination in low resource settings because they are typically delivered in group settings with minimal need for equipment.

Several professional organizations have recently published statements or practice guidelines regarding the use of MBIs, including the UK National Institute for Health and Care Excellence (2018) and the Canadian Network for Mood and Anxiety Treatments (CANMAT) (Ravindran et al., 2016). Although recommendations from these organizations support, for example, the use of mindfulness or yoga as add-on treatment for mild to moderate depression, recommendations for other MBIs are more equivocal, mainly because of a lack of a comprehensive, methodologically robust summary of the available evidence.

Despite the common use of MBIs in the treatment of mental disorders, there is no summary of the evidence, nor is there a direct quantitative comparison of the evidence between all individual and/or combined MBIs. Moreover, the quality of these meta-analyses and the included trials has not been comprehensively evaluated, which is an indispensable step before more rigorous recommendations regarding MBIs in mental health care programs can be made (Gureje et al., 2015). Clear recommendations are needed as meditation-based mind-body approaches are not only becoming more popular, but also only half of those who participate report this to their health practitioner (Cheung et al., 2007). Therefore, it is important for mental health professionals to be familiar with the benefits, but also risks of active MBIs in general and for specific approaches so that implementation of active MBIs can be discussed together with the patient.

In order to address the current gap within the literature, we set out to evaluate, compare and aggregate the existing evidence from the most recent/largest, published meta-analyses of randomized trials of different MBIs (i.e. mindfulness, qigong, tai chi, and yoga) in people with a mental disorder in order to determine the quality of evidence and magnitude of efficacy for MBIs targeting mental health outcomes. Moreover, we provide an overview of the reported adverse events and attrition rates.

2. Methods

2.1. Searches

Two independent authors (DV and TVD) searched MEDLINE/PubMed, PsycARTICLES and EMBASE from inception to 06/2020, for systematic reviews with meta-analyses of randomised controlled trials (RCTs) investigating MBIs as add-on or sole treatment across a range of mental disorders. Separate searches were undertaken for each mental disorder categorisation using the following standard terms: (mind-body, mindfulness, qigong, tai chi, yoga) and (systematic review or meta-analysis or meta* or metanalytic review); and (a) (schizophrenia or psychosis or psychotic or major depression (MDD) or depression or bipolar disorder or serious mental illness or serious mental disorder), or (b) (anxiety disorder or generalised anxiety disorder (GAD) or post-traumatic stress disorder (PTSD) or obsessive compulsive disorder (OCD) or panic disorder), or (c) (alcohol use disorder or alcohol addiction or substance use disorder or drug addiction or addiction*) or (d) eating disorders (eating disorder or anorexia* or bulimia* or binge eating disorder) or (e) mild cognitive impairment or dementia or Alzheimer's diseases) or (f) (ADHD or attention-deficit hyperactivity disorder or autism). Reference lists of included articles were searched.

2.2. Eligibility criteria

We included meta-analyses of RCTs investigating MBIs. MBIs were defined as health care practices focusing on the relationships among the mind, body, brain, and behaviour that are not currently considered a part of Western medicine and which are characterized by incorporating exercises including controlled physical movements, full-body stretching, breathing techniques, and a meditation component (Gellis, 2017; Sabe et al., 2019). We focus on the MBIs, i.e. mindfulness, qigong, tai chi, and yoga as add-on or mono-therapy in the following conditions: (a) serious mental illness (including schizophrenia spectrum, bipolar disorder and MDD); (b) anxiety and stress disorders (e.g. PTSD, OCD, GAD); (c) alcohol use disorders and substance use disorders, (d) eating disorders (anorexia nervosa, bulimia nervosa, binge eating disorder); (e) dementia); and (f) other mental disorders, including attention-deficit disorder (ADHD) and autism. Only meta-analyses including people with mental illnesses diagnosed through structured clinical diagnoses were included. Meta-analyses that included people with mental illness/substance use disorders and mental health symptoms were only included if over 80% of the studies had a diagnosed mental illness. If this was not possible, we attempted to extract information on

any subgroup meta-analysis results for those with confirmed mental illness. We included studies with data on young people (<18 years), adults (18<65 years) and older adults (65≤ years). Mindfulness interventions in combination with other modalities (e.g., cognitive techniques as in mindfulness-based cognitive therapy) were included, but mindfulness-based therapies emphasizing the attitudinal stance of mindfulness rather than the formal practice of mindfulness throughout body-mind exercises were excluded (e.g., acceptance and commitment therapy or dialectical behaviour therapy). Other forms of meditation (e.g., mantra repetition) were excluded. We did not include aerobic exercise or resistance training interventions as the therapeutic benefit of these interventions is theoretically derived from components separate to MBIs itself. If we encountered meta-analyses including interventions with low-intensity PA, we included these only if over 80% of the RCTs utilised MBIs. We included meta-analyses that considered MBIs as monotherapy or in combination with other types of treatment, e.g. psychotropic medication or psychological interventions. Control interventions included wait-list conditions, care as usual, passive concentration conditions such as relaxation, psychoeducation and evidence-based control conditions such as pharmacotherapy, psychotherapy and aerobic exercise.

2.3. Primary outcomes

Primary outcomes were changes in mental health symptoms which characterise the target disorders, e.g. positive/negative symptoms in schizophrenia spectrum disorders, depressive symptoms in MDD, anxiety levels in anxiety/stress disorders, cognitive outcomes in Alzheimer`s disease, or substance use in substance use disorders, as assessed by valid measures.

2.4. Secondary outcomes

We also examined changes in secondary outcomes reported in meta-analyses of RCTs, such as comorbid mental health symptoms (e.g. depression in schizophrenia spectrum disorders), physical and/or psychological quality of life or social wellbeing, neurocognitive function, etc assessed by valid measures. Adverse effects and attrition rates were recorded when available.

2.5. Data extraction, outcomes, and data synthesis

Regarding the efficacy of the MBIs, two authors (DV and TVD) manually extracted effect size data (95% confidence intervals (CI)) for all relevant outcomes, and the number of participants in the intervention

and control arms for each effect size. Specifically, data for effect sizes of continuous outcomes were extracted or recalculated as standardized mean difference (SMD), which expresses the mean difference between the intervention and control groups in standard deviation units, Hedge's g or Cohen's d, and this with 95% confidence intervals. An effect size of less than 0.2 is considered negligible, an effect size between 0.2 and less than 0.5 is small, 0.5 and less than 0.8 is medium, and of at least 0.8 is large (Cohen, 1988). Risk and odds ratios were used for categorical outcomes.

2.6. Risk of bias (quality) assessment

Two independent authors (DV and TVD) assessed the quality of the meta-analyses using the AMSTAR (Shea et al., 2009) and AMSTAR+ (Correll et al., 2017) tool. The AMSTAR is a reliable and valid tool to capture the methodological quality of meta-analyses but does not capture key quality indicators of the meta-analysed trials (range = 0-11 with a score of 8 or higher indicating 'high quality'). In accordance with previous meta-reviews (Correll et al., 2017; Vancampfort et al., 2019) we used the AMSTAR+ which has six additional items on the content validity of the included trials in the meta-analyses with scores ranging from 0 to 8 (≥ 4 indicating 'high quality').

2.7. Statistical analysis

We intended to directly compare different MBIs across different mental health diagnoses for comparable outcomes where there was sufficient homogeneity. However, the included MBIs, populations and outcomes were too heterogenous to enable meaningful comparison. Thus, we extracted effect size data directly from the published meta-analyses. If only raw data and no standardized effect sizes were available, standardized outcomes were calculated using comprehensive meta-analysis (CMA, version 3) (Biostat). Where possible we extracted information on heterogeneity using the I^2 statistic, with scores of <25%, 25-50% and >50% indicating low, moderate and high heterogeneity, respectively (Higgins et al., 2003).

3. Results

3.1. Systematic search results

Of 4009 search engine hits, 17 meta-analyses were included (Chi et al., 2018; Chu et al., 2018; Cramer et al., 2018; Cramer et al., 2013; Goldberg et al., 2018; Grant et al., 2017; Guo et al., 2019; Hartley et al., 2019; Hopwood and Schutte, 2017; Jansen et al., 2019; Kuyken et al., 2016; Miller et al., 2020; Sabe et al., 2019; Vollbehr et al. 2018; Xue et al., 2019; Zhang et al., 2018; Zheng et al., 2016) (see Figure 1). There was one meta-analysis in mental disorders in general (Goldberg et al., 2018), one in bipolar disorder (Chu et al., 2018), one in substance use disorders (Grant et al., 2017), one in ADHD (Xue et al., 2019) and one in autism (Hartley et al., 2019). Three (Cramer et al., 2018; Hopwood and Schutte, 2017; Vollbehr et al., 2018) meta-analyses focused on anxiety and stress related disorders, four (Cramer et al., 2013; Jansen et al., 2019; Sabe et al., 2019; Zhang et al., 2018) on schizophrenia spectrum disorders and six (Chi et.al., 2018; Guo et al., 2019; Kuyken et al., 2016; Miller et al., 2020; Vollbehr et al., 2018; Zhang et al., 2018) on MDD. The majority of the meta-analyses explored the evidence for mindfulness (N = 10) (Chi et al., 2018; Chu et al., 2018; Goldberg et al., 2018; Grant et al., 2017; Hartley et al., 2019; Hopwood and Schutte, 2017; Jansen et al., 2019; Kuyken et al., 2016; Xue et al., 2019; Zhang et al., 2018), followed by yoga (N = 3) (Cramer et al., 2018; Cramer et al., 2013; Vollbehr et al., 2018), tai chi (N = 1) (Zheng et al., 2016), and qigong (N = 1) (Guo et al., 2019). Two (Miller et al., 2020; Sabe et al., 2019) meta-analyses focused on MBIs in general, i.e. pooling mindfulness, qigong, tai chi, and yoga data. Details of the included meta-analyses are summarized in Table 1.

Insert Figure 1 about here

Insert Table 1 about here

3.2. Quality assessment of the included meta-analyses

The quality assessment of the 17 meta-analyses is provided in Table 2. The AMSTAR mean score was 8.2 (0.9) in the whole sample. Sixteen (94%) (Chi et al., 2018; Chu et al., 2018; Cramer et al., 2013; Goldberg et al., 2018; Grant et al., 2017; Guo et al., 2019; Hartley et al., 2019; Jansen et al., 2019; Kuyken et al., 2016; Miller et al., 2020; Sabe et al., 2019; Vollbehr et al., 2018; Xue et al., 2019; Zhang et al., 2018; Zheng et al., 2016) meta-analyzed studies had an AMSTAR score of eight or higher, but none had the maximum AMSTAR score of 11.

Insert Table 2 about here

The AMSTAR-Plus Content scores are summarized in Table 3. The mean score was 3.1 (1.5). None had the maximum score of eight. Nine (53%) (Chi et al., 2018; Goldberg et al., 2018; Grant et al., 2017; Hopwood and Schutte, 2017; Jansen et al., 2019; Kuyken et al., 2016; Miller et al., 2020; Sabe et al., 2019; Xue et al., 2019) meta-analyses were rated as high quality based on the meta-analyzed studies with a score of 4 or higher. In 7 (41%) meta-analyses (Chu et al., 2018; Cramer et al., 2018; Cramer et al., 2013; Guo et al., 2019; Hartley et al., 2019; Vollbehr et al., 2018; Zhang et al., 2018; Zheng et al., 2016) the total pooled sample was less than 500 cases, while 7 (41%) other meta-analyses (Chi et al., 2018; Goldberg et al., 2018; Hopwood and Schutte, 2017; Jansen et al., 2019; Kuyken et al., 2016; Sabe et al., 2019; Xue et al., 2019) had a total sample of more than 1000 participants. Five (28%) meta-analyses (Chi et al., 2018; Grant et al., 2017; Jansen et al., 2019; Kuyken et al., 2016; Sabe et al., 2019) had one included trial with at least 200 participants. Finally, following the AMSTAR-Plus Content criteria, a significant heterogeneity for the outcome was found for 11 (66%) meta-analyses (Chi et al., 2018; Chu et al., 2018; Cramer et al., 2018; Cramer et al., 2013; Goldberg et al., 2018; Hartley et al., 2019; Jansen et al., 2019; Kuyken et al., 2016; Sabe et al., 2019; Xue et al., 2019; Zheng et al., 2016), and 10 (59%) (Chi et al., 2018; Chu et al., 2018; Cramer et al., 2018; Cramer et al., 2013; Goldberg et al., 2018; Grant et al., 2017; Hartley et al., 2019; Sabe et al., 2019; Vollbehr et al., 2018; Zhang et al., 2018; Zheng et al., 2016) could not disprove the presence of a publication bias.

Insert Table 3 about here

3.3. MBIs in general

One meta-analysis (Sabe et al., 2019) explored the efficacy of MBIs in general (pooled data for mindfulness, qigong, and yoga) versus treatment-as-usual or non-specific control interventions and found a moderate effect for reductions in negative symptoms (N = 15; n MBIs = 549; n controls = 532; I^2 = 62%) and no effect on positive symptoms (N = 14; n MBIs = 534; n controls = 517; I^2 = 54%) in people with schizophrenia or schizoaffective disorder (AMSTAR = 8; AMSTAR+ = 4). Another meta-analysis (Miller et al., 2020) explored the efficacy of MBIs in general in older patients with depression (aged 65 and older) and observed a large effect for reductions in depression compared with a waitlist condition and compared with an attention control condition, although these differences were non-significant. Also, no difference in effects for reductions in depression versus aerobic exercise or versus

resistance training were found (N = 15; n MBIs = 321; n controls = 275; AMSTAR = 9; AMSTAR+ = 4). An overview of the findings can be found in Table 1.

3.4. Mindfulness

As can be noticed in Table 1, large effects were observed for: (a) long-term (≥3 months) reductions in schizophrenia symptomatology versus waitlist, treatment as usual or other active conditions (N = 5; n mindfulness = 293, n controls = 292; I^2 = 97%; AMSTAR = 8; AMSTAR+ = 5) (Jansen et al., 2019), and (b) improvements in attention (N = 11; n mindfulness= 342; n controls = 340; I^2 = 76%; AMSTAR = 9; AMSTAR+ = 4) versus active and inactive conditions in people with ADHD (Xue et al., 2019). Another meta-analysis (Hartley et al., 2019) demonstrated a large effect of mindfulness versus a waitlist condition on improvements in subjective well-being in adults with autism, but this was only based on one RCT including 41 participants (AMSTAR = 10; AMSTAR+ = 2). Moderate effects for mindfulness were reported for: (a) mental health symptoms reductions compared to no treatment in people with a mental disorder (N RCTs = 90; n mindfulness = 2,966; n controls = 2,782; I^2 = 58%; AMSTAR = 8; AMSTAR+ = 4) (Goldberg et al., 2018), (b) short-term reductions in schizophrenia symptoms versus waitlist, treatment as usual or other active conditions (N = 5; n mindfulness = 246; n controls = 249; I^2= 26%; AMSTAR = 8; AMSTAR+ = 5) (Jansen et al., 2019), and (c) reductions in hyperactivity and impulsivity versus active and inactive conditions in people with ADHD (N = 11; n mindfulness= 342; n controls = 340; I^2 = 69%; AMSTAR = 9; AMSTAR+ = 4) (Xue et al., 2019). Moderate effects were also found for PTSD symptom reductions compared with a waitlist condition (N=17, n = 1863; AMSTAR = 8; AMSTAR+ = 5) (Hopwood and Schutte, 2017). Small effects were observed for mental health symptoms reductions compared to minimal treatment in people with a mental disorder (N = 5; n mindfulness = 311; n controls = 246; I^2 = 33%; AMSTAR = 8; AMSTAR+ = 4) (Goldberg et al., 2018), (b) short-term (N = 18; n mindfulness = 1056; n controls = 986; I^2 = 69) but not long-term reductions in depression in adolescents and young adults (AMSTAR = 8; AMSTAR+ = 4), (c) positive (N = 3; n MBIs = 153; n controls = 164; I^2 = 51%) and negative (N = 10; n MBIs = 330; n controls = 304; I^2 = 73%) symptoms reductions versus treatment-as-usual or non-specific control interventions (AMSTAR = 8; AMSTAR+ = 4) (Sabe et al., 2019), and (d) PTSD symptom reduction compared with other active treatments (N=17, n = 1863; AMSTAR = 8; AMSTAR+ = 5) (Hopwood and Schutte, 2017). Mindfulness interventions resulted also in a significantly lower risk for relapse versus non-mindfulness treatment (N = 9; n mindfulness = 596; n

controls = 662; I^2=2%; AMSTAR = 7; AMSTAR+ = 5;), versus other active treatments (N = 5; I^2 = 0%; AMSTAR = 7; AMSTAR+ = 5;) and versus the use of antidepressants in those with recurrent depression (N = 4; I^2 = 0%; AMSTAR = 7; AMSTAR+ = 5). A negligible but significant reduction in withdrawal / craving symptoms was found versus any kind of control conditions in people with substance use disorders (N = 5; I^2 = 0%; AMSTAR = 10; AMSTAR+ = 4) (Grant et al., 2017). In people with bipolar disorder (Chu et al., 2018) adjunctive mindfulness interventions did not have an effect on depressive (N = 3; n mindfulness = 73; n controls = 59; I^2 = 75%) and anxiety symptoms (N = 3; n mindfulness = 73; n controls = 59; I^2 = 85%), and no effects were observed on relapse (N = 7; n = 841; I^2 = 0%), frequency of use (N = 5; n = 718; I^2 = 42%), and co-morbid anxiety (N = 4; I^2 = 78%) and depression (N = 4; I^2 = 0%) versus control conditions in people with substance use disorders (Grant et al., 2017). Finally, no significant effect was found for mindfulness in reducing positive symptoms compared to treatment-as-usual or non-specific control interventions (N = 3; n mindfulness = 153; n controls = 164; I^2=51%).

3.5. Qigong

A large effect was reported for reductions in depression versus passive control conditions (AMSTAR = 8; AMSTAR+ = 3; N = 5; I^2 = 48%), while moderate effects were observed for reductions in depression following movement qigong (AMSTAR = 8; AMSTAR+ = 3; N = 7; I^2 = 42%). Small effects were reported for reductions in depression of qigong versus active control conditions in adults (AMSTAR = 8; AMSTAR+ = 3; N = 4; I^2 = 23%). No effects were seen for static qigong versus control conditions (AMSTAR = 8; AMSTAR+ = 3; N = 2; I^2 = 68%).

3.6. Tai Chi

While one meta-analysis did not observe an effect of tai chi in people with schizophrenia (AMSTAR = 8; AMSTAR+ = 4) (Sabe et al., 2019), another meta-analysis (Zheng et al., 2016) including also RCTs published in Chinese did find a large effect of tai chi on negative symptoms (Zheng et al., 2016) (N = 6; n tai chi = 200; n controls = 251; I^2 = 90%). However, the content validity of the included RCTs in the latter meta-analysis can be questioned (AMSTAR+ = 1).

3.7. Yoga

Large effects for yoga were observed for reductions in PTSD symptoms versus no treatment (e.g. waitlist) (N = 5; n yoga = 111; n controls = 95; I^2 = 72%), although the methodological quality of the findings can be questioned (AMSTAR = 7; AMSTAR+ = 1) (Cramer et al., 2018). A meta-analysis in people with schizophrenia (Cramer et al., 2013) did also find a large effect on quality of life improvements following yoga versus usual care (N = 2; n yoga = 48; n controls = 50; I^2 = 89%), but also in this meta-analysis the content validity of the included RCTs dan be questioned (AMSTAR+ = 1). Moderate effects were observed for reductions in depression following yoga versus care as usual (N = 5; I^2 = 93%) and versus psychoeducation (N = 6; I^2 = 56%). Again, the quality of the included RCTs is low (AMSTAR+ = 2). A small effect was seen for a reduction in positive and in negative symptoms (N = 10, n yoga = 330; n controls = 304; I^2=73%; AMSTAR = 8; AMSTAR+ = 4) (Sabe et al., 2019). No effects were found for: (a) improvements in social functioning versus usual care in schizophrenia (Cramer et al., 2013), (b) reductions in positive symptoms versus treatment-as-usual or non-specific control interventions (Sabe et al., 2019), (c) reductions in anxiety or depression versus active control conditions including mindfulness or walking (Vollbehr et al., 2018), and (d) reductions in PTSD versus attention control conditions such as health education (Cramer et al., 2018).

3.8. Adverse events

Seven meta-analyses reported adverse events (Chu et al., 2018; Cramer et al., 2013; Grant et al., 2017; Jansen et al., 2019; Kuyken et al., 2016; Miller et al., 2020; Zheng et al., 2016) (N RCTs which assessed events = 43; n in the MBI arms = 1774). Of these seven meta-analyses, only one adverse event (Grant et al., 2017) was reported. Specifically, one participant with a substance use disorder reported experiencing nightmares, increased anxiety, and trauma memories at a follow-up visit following mindfulness.

3.9. Attrition rates

Four meta-analyses (N RCTs = 37; n = 2,288) reported attrition and retention rates. A meta-analysis (Miller et al., 2020) exploring MBIs in older people with depression demonstrated that the attrition was very similar for MBIs (11.8 %) compared with resistance exercise (10.5 %) and aerobic exercise (7.6 %). Other meta-analyses showed that there was no difference in discontinuation rate between tai chi

and control conditions in people with schizophrenia (Zheng et al., 2016), no difference in discontinuation rate between yoga and control conditions in people with PTSD (Cramer et al., 2018) and no difference in treatment dropout in mindfulness versus control conditions in people with substance use disorders (Grant et al., 2017) (see Table 1 for detailed data).

4. Discussion

To our knowledge, this overview of 17 meta-analyses of RCTs is the first to systematically assess the effects of MBIs in people with a mental disorder. Our data sheds new light on the state of the current evidence base. The current overview may help guide clinical practice and set a precedent of where future research priorities should focus.

In summary, we found potential large effects (i.e. effect sizes of at least 0.8) (Higgins et al., 2003) in meta-analyses with good methodological quality (AMSTAR 8≤) (Shea et al., 2009) and content validity (AMSTAR+ 4≤) (Correll et al., 2017) for: (a) long-term (≥3 months) reductions in symptomatology in people with psychosis following mindfulness versus waitlist, treatment as usual or other active conditions (Jansen et al., 2019); and (b) improvements in attention for mindfulness versus active and inactive conditions in people with ADHD (Xue et al., 2019). Moderate effects (i.e. effect sizes between 0.5 and 0.80) (Higgins et al., 2003) in meta-analyses with a good methodological quality (AMSTAR 8≤) (Shea et al., 2009) and content validity (AMSTAR+ 4≤) (Correll et al., 2017) were observed for: (a) reductions in mental health symptoms for mindfulness-based interventions compared to no treatment in people with a mental disorder (Goldberg et al., 2018), (b) long-term (≥3 months) reductions in symptomatology in people with psychosis following mindfulness versus waitlist, treatment as usual or other active conditions (Jansen et al., 2019), (c) reductions in negative symptoms following MBIs interventions in general versus treatment-as-usual or non-specific control interventions in people with schizophrenia (Sabe et al., 2019), and (d) reductions in PTSD symptoms for mindfulness compared with a waitlist condition (Hopwood and Schutte, 2017). Small effects (i.e. effect sizes between 0.2 and 0.50) (Higgins et al., 2003) in meta-analyses with a good methodological quality (AMSTAR 8≤) (Shea et al., 2009) and content validity (AMSTAR+ 4≤) (Correll et al., 2017) were reported for: (a) reductions in mental health symptoms for mindfulness-based interventions compared to minimal treatment (Goldberg et al., 2018), (b) reductions in negative symptoms in people with psychosis following mindfulness versus treatment-as-usual or non-specific control interventions (Sabe et al., 2019), (c) reductions in positive and in negative symptoms following yoga versus treatment-as-usual or non-specific control interventions in people with psychosis (Sabe et al., 2019), short-term reductions in depression following mindfulness versus waitlist, treatment as usual or active control condition (e.g., health education or relaxing activities) in adolescents and young adults (Chi et al., 2018), and (e) PTSD symptom reduction following mindfulness compared with other active treatments (Hopwood and Schutte, 2017). A negligible effect

(i.e. effect size smaller than 0.20) (Higgins et al., 2003) was seen for a reduction in withdrawal / craving symptoms for mindfulness versus control conditions in people with substance use disorder (Grant et al., 2017). There was also evidence from meta-analyses with good methodological quality (AMSTAR 8≤) (Shea et al., 2009) and content validity (AMSTAR+ 4≤) (Correll et al., 2017) for reduced relapse risk in people with depression following mindfulness versus active treatments and antidepressants (Kuyken et al., 2016).

Overall, while our meta-review of meta-analyses supports the notion that MBIs, and in particular mindfulness, hold promise as evidence-based adjunctive treatments in a wide range of mental disorders, it remains difficult to make firm recommendations. This is due to the heterogeneity in effects across disorders, the uneven distribution of studies across disorders, the limited sample sizes in a majority of the trials, relative scarcity of direct comparisons between MBIs and other first-line treatments and evidence of publication bias in the majority of the meta-analyses. With these caveats in mind, current evidence supports the following conclusions.

For people with schizophrenia spectrum disorders, negative symptoms, rather than positive symptoms will benefit from adding MBIs into the treatment. In depression, the strongest evidence was available for mindfulness, while no meta-analysis of RCTs was available for tai chi. A recent review of tai chi for people with MDD (Kong et al., 2019) however indicated that there is preliminary evidence for reductions in depressive symptoms. In particular simplified and less structured tai chi is a promising MBI (Kong et al., 2019). Also, in people with an anxiety disorder, most evidence was available for mindfulness but not when compared with other evidence-based interventions. In people with autism and ADHD only mindfulness interventions were explored. A systematic review on MBIs in people with autism indicated that the mental health status improves with different mind - body therapies in people with autism, but the evidence was of low quality and would benefit from larger RCTs (Hourston and Atchley, 2017). Many MBIs use figurative language, which can be challenging for people with autism who are more likely to take language literally. However, with smaller group sizes in the sessions, shortened exercises, a focus on sensory exercises and a limited use of metaphors benefits can be obtained (Hourston and Atchley, 2017). A systematic review of MBIs in ADHD found positive effects on ADHD symptoms from yoga and tai chi (Herbert and Esparham, 2017). Only limited evidence was available for the use of mindfulness in substance use disorders and no meta-analyses including RCTs were published in people with eating disorders, mild cognitive impairment or dementia. A meta-analysis in the general population supported

large or medium-large effects of MBIs for binge eating (within-group Hedge's g = -1.12, 95 % CI = -1.67 to -0.80, n = 19; between-group mean Hedge's g = -0.70, 95 % CI = -1.16 to -0.24, n = 8) (Godfrey et al., 2015), while for anorexia nervosa the evidence is more equivocal (Dunne, 2018; Linardon et al., 2017). Despite the fact that no meta-analyses of RCTs only on the efficacy of MBIs in mild cognitive impairment or dementia are available, there is recent evidence that, for example, tai chi has potential to reduce the incidence of falls and improve quality of life in this population (Nyman et al., 2019). A meta-analysis including 9 RCTS and 3 non-RCTs involving 1298 people with mild cognitive impairment indicated that MBIs significantly improved attention (SMD = 0.39, 95% CI = 0.07 to 0.71, P = 0.02, I^2 = 32%, n = 245), short-term memory (SMD = 0.74, 95% CI = 0.57 to 0.90, P<0.001, I^2 = 0%, n = 861), executive function (SMD = -0.42, 95% CI -0.63 to -0.21, P<0.001, I^2 = 39%, n = 701), visual-spatial/executive function (SMD = 0.35, 95% CI = 0.07 to 0.64, P<0.05, I^2 = 0%, n = 285), and global cognitive function (SMD = 0.36, 95% CI = 0.2 to 0.52, P<0.001, I^2 = 15%, n = 902), while no effect on cognitive processing speed was observed (SMD = 0.31, 95% CI -0.01 to 0.63, P=0.054, I^2 = 29%, n = 233) (Zou et al., 2019).

From a practical perspective, a relevant finding of this meta-review is that based on 7 meta-analyses, including 43 trials and 1,774 participants in the MBI condition, except for one case, no adverse events were found. This indicates that MBIs might be safely introduced within multidisciplinary treatment protocols. Another important finding with clinical implications was that based on 4 meta-analyses, including 37 trials and 2,288 participants, attrition rates were not significantly different from other well-accepted and evidence-based complementary treatments such as aerobic exercise.

Despite the fact that adverse events and attrition rates were not always reported, the available data indicate that MBIs are well-tolerated. Moreover, MBIs could be offered as an add-on within multidisciplinary treatment protocols in venues that are not associated with the stigma of mental health care, such as at primary care practices and community settings. However, there are some potential practical challenges for implementation of MBIs in real-world settings as well, including lack of qualified mind-body professionals with expertise in working with people with mental disorders in some places and non-standardized practices in others. Further, long-term adherence needs to be explored. For example, a meta-analysis of mindfulness in adolescents with depression found evidence for short-term but not for long-term reductions in depression [30]. It is possible that young people may need more time to understand the meaning of MBIs and form practice habits in their daily life compared to adults. Future studies could

explore, for example, whether young people lose interest in meditation-based mind-body practices and are less likely to persist if they did not get a solid practice foundation during the treatment period.

While mechanisms underpinning the mental health benefits of MBIs are not fully understood, there may be a number of explanations. For example, recent studies have suggested that MBIs may reduce stress and modulate inflammatory processes associated with a wide range of mental disorders (Bower and Irwin, 2016; Buric et al., 2017; Morgan et al., 2014). Neuroimaging studies suggest that MBIs increase grey matter in the brain regions related to emotion regulation, learning, memory, and self-referential processes (Hölzel et al., 2011a; Vestergaard-Poulsen et al., 2009). However, the latter evidence was only for mindfulness interventions and the generalizability of the findings to other MBIs might be questioned. Other research suggests that improvements in body awareness and emotion regulation may be responsible for the positive effects of MBI on mental health (Hölzel et al., 2011b). An emerging field of research is focused on relationships between MBIs, improvements to the diversity and composition of the gut microbiota and mental health (Clapp et al., 2017).

Our data should be considered in the light of some significant limitations. First, although the included meta-analyses were the most updated and/or largest for each specific MBI and outcome, individual studies published since the last search date of included meta-analyses have not been added. Second, while the quality of the methods of the meta-analyses was generally good to very good with AMSTAR scores in all except one meta-analysis above 8, the content often lacked quality, suggesting a rather low evidence level for all interventions. A risk of bias cannot be excluded in the meta-analyzed RCTs, that could not be blinded due to the nature of the intervention. Third, most trials included in the meta-analyses were rather small, or were not confirmed by a larger trial. Fourth, the heterogeneity was moderate to high across many meta-analyzed trials. Fifth, based on the current AMSTAR Plus Content scores publication bias was potentially problematic for 10 of the 17 meta-analyses, potentially overestimating the pooled effect sizes. Methodologically excellent and sufficiently large individual RCTs are therefore essential, because when meta-analyzed they can compensate for the bias introduced by poor-quality and small trials. Additionally, the field should advance by moving from study-level to patient-level meta-analyses, as this would provide a more personalized picture of treatment effects for individuals derived from adequately powered moderator, mediator, and subgroup analyses. For instance, a patient-based meta-analysis comparing the effects of MBIs with for example pharmacotherapy might be able to identify specific patient subgroups who respond adequately to MBIs

as a first line of treatment. Future research is also needed to explore the underlying mechanisms in more detail and should explore which individuals may be most benefited by MBIs. For example, it should be investigated whether there are certain individual differences (genetic or neurobiological) that predict the magnitude of change. Finally, future research should explore the cost-effectiveness of including MBIs within mental health care settings and whether the qualification of the MBI provider influences the treatment outcome and attrition rates.

In conclusion, mainly mindfulness may serve as an efficacious supplement to pharmacotherapy and psychotherapy, and can be considered an efficacious add-on intervention in the treatment of a wide range of mental disorders. To a lesser extent also yoga is efficacious as an add-on MBI in people with schizophrenia. While there is evidence for reductions in depression following movement qigong, and a reduction in negative symptoms following tai chi, the content validity of the included RCTs exploring qigong and tai chi can be questioned. Adequately powered RCTs are needed to be able to investigate the evidence for tai chi and qigong in more detail. For community, primary and mental health settings, further research is still required to improve the evidence-based implementation of mindfulness.

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Conflicts of interest

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Table 1. Overview of the included meta-analyses on mind-body interventions in people with a mental disorder

Reference	Participants	MBIs and control interventions	Effect sizes, adverse events and attrition rates
Jansen et al. (2020)	629 (n mindfulness = 316; n controls = 313) (24-27yrs) with a psychotic disorder or schizophrenia spectrum disorder (DSM-IV or ICD-10) in 7 RCTs	Mindfulness vs. waitlist, treatment as usual or other active condition	• Short-term symptomatology: SMD = -0.71, 95% CI = −0.94 to −0.49; p<0.001; I²= 26%; N = 5, n mindfulness = 246; n controls = 249. • Long-term (≥3 months) symptomatology: SMD = -1.60; 95% CI = −2.82 to −0.38; p=0.01; I² = 97%; N = 5, n mindfulness = 293; n controls = 292. • No adverse events were present in 7 RCTs. • No attrition rates were available.
Miller et al. (2020)	596 (n MBIs = 321, n controls = 275) with a clinical depression (DSM-IV or ICD-10) aged 65 yrs or older in 15 RCTs	MBIs in general including yoga, tai chi, qigong vs. wait list, attention control, aerobic exercise or resistance training	• Depression (vs. waitlist): Hedges' g = −1.15, CI = −2.31 to 0.01. • Depression (vs. attention control): Hedges' g = −0.87, CI = −1.74 to 0.00. • Depression (vs. aerobic exercise): Hedges' g = −0.36, PrI = −2.69 to 1.97. • Depression (vs. resistance exercise): Hedges' g = −0.46, PrI = −2.75 to 1.83. • No adverse events were present in any of the 15 RCTs. • Attrition was very similar for MBIs (11.8 %), compared with resistance exercise (10.5 %) and aerobic exercise (7.6 %).
Guo et al. (2019)	382 with major depressive disorder (DSM-IV) in 7 RCTs	Qigong vs. passive and active control conditions	• Treatment response rate (vs. waitlist): OR = 4.38, 95% CI = 1.26 to 15.23; p = 0.02; N= 2; n = 114. • Remission rate (vs. waitlist): OR = 8.52, 95% CI = 1.91 to 37.98; p = 0.005; N= 2; n = 114. • Depression (vs. active control group): Hedges' g = -0.47, 95% CI = -0.81 to -0.12; p = 0.01; I² = 22.75%; N = 4. • Depression (vs. passive control group): Hedges' g = -0.80, 95% CI = -1.23 to -0.37; p < 0.01; I² = 48.07%; N = 5. • Depression (movement Qigong vs. control): Hedges' g = -0.62, 95% CI = -0.96 to -0.28; p < 0.01; I² = 41.62%; N = 7. • Depression (Static Qigong / mindfulness vs. control): Hedges' g = -0.67, 95% CI = -1.38 to 0.04; p = 0.06; I² = 67.84%; N = 2. • No adverse events and attrition rates were available.
Hartley et al. (2019)	74 children (14±2yrs) and 139 adults with autism (38±10 yrs)	Mindfulness vs. waitlist	• Subjective well-being in adults (vs. waitlist) : Hedges' g= 0.87, 95 CI = 0.65 to 1.09; p<0.001; N = 1; N =41. • No adverse events and attrition rates were available.
Kuyken et al. (2019)	1,258 (n mindfulness = 596, n controls = 662) with recurrent major depressive disorder currently in remission (DSM or ICD) (47±12 years; 75% female) in 9 RCTs	Mindfulness vs. non-mindfulness interventions	• Relapse (vs. non-MBCT treatments): HR = 0.69; 95% CI = 0.58 to 0.82; I² = 1.7%; N = 9; n mindfulness = 596; n controls = 662. • Relapse (vs. active treatments): HR = 0.79; 95% CI = 0.64 to 0.97; I²= 0%; N = 5. • Relapse (vs. antidepressants): HR = 0.77; 95% CI = 0.60 to 0.98; I²= 0%; N = 4. • No adverse events were present in 6 RCTs. • No attrition rates were available.

Table 1. Continued

Reference	Participants	MBIs and control interventions	Effect sizes, adverse events and attrition rates
Sabe et al. (2019)	1,081 (n MBIs = 549, n controls = 532) with schizophrenia or schizoaffective disorder (DSM IV) in 15 RCTs	MBIs in general including yoga, tai-chi, qigong, mindfulness vs. treatment-as-usual or non-specific control interventions	• MBIs in general on negative symptoms: SMD = -0.36, 95% CI = -0.58 to -0.15; p<0.001; I^2=62%; N = 15, n MBIs = 549; n controls = 532. • Tai Chi on negative symptoms: SMD = -0.16, 95% CI = -0.50 to 0.19; p=0.38; I^2=0%; N = 2, n tai chi = 66; n controls = 64. • Yoga on negative symptoms: SMD = -0.39, 95% CI = -0.72 to -0.06; p=0.02; I^2=73%; N = 10, n yoga = 330; n controls = 304. • Mindfulness on negative symptoms: SMD = -0.45, 95% CI = -0.67 to -0.23; p < 0.0001; N = 3, n mindfulness = 153; n controls = 164. • MBIs in general on positive symptoms: SMD = -0.19, 95% CI = -0.39 to 0.00; p=0.05; I^2=54%; N = 14, n MBIs = 534; n controls = 517. • Yoga on positive symptoms: SMD = -0.27, 95% CI = -0.53 to -0.01; p=0.04; I^2=56%; N = 10, n yoga = 330; n controls = 304. • Mindfulness on positive symptoms: SMD = -0.16, 95% CI = -0.54 to 0.22; p = 0.41; I^2=51%; N = 3; n mindfulness = 153; n controls = 164. • No adverse events and attrition rates were available.
Xue et al. (2019)	682 with ADHD (DSM V): 210 children and 472 adults in 11 RCTs (n mindfulness= 342, n controls = 340)	Mindfulness vs. active and inactive conditions	• Inattention: Hedges' g = -0.82, 95% CI=-1.16 to -0.49; p<0.001; I^2 = 76%; N = 10; n mindfulness = 342; n controls = 340. • Hyperactivity / impulsivity: Hedges' g = -0.68, 95% CI=-0.97 to -0.38; p<0.001; I^2 = 69%; N = 11; n mindfulness= 342; n controls = 340. • No adverse events and attrition rates were available.
Cramer et al. (2018)	308 (n yoga = 163, n controls = 145) with PTSD (29-58 years; 73% male) in 7 RCTs	Yoga vs. no treatment or attention control	• PTSD symptoms (vs. no treatment conditions): SMD = − 1.10, 95% CI =-1.72 to -0.47; p<0.001; I^2 = 72%; N = 5; n yoga = 111; n controls = 95. • PTSD symptoms (vs. all attention control conditions only): SMD = − 0.31, 95% CI =-0.84 to 0.22; p=0.25; I^2 = 43%; N = 2; n yoga = 52; n controls = 50. • Retention was comparable between yoga and no treatment: OR = 0.68, 95%CI= 0.06 to 7.72; p = 0.75) and between yoga and attention control: OR = 0.66, 95%CI = 0.10 to 4.46, p = 0.67. • No adverse events reported.
Chi et al. (2018)	2,042 (n mindfulness = 1056, n controls = 986) with depression (DSM-IV or ICD-10) aged 12 to 25 years in 18 RCTs	Mindfulness vs. waitlist, treatment as usual or active control condition (e.g., health education or relaxing activities)	• Hedges' g post-intervention = -0.45, 95% CI = -0.63 to -0.27; S; I^2 = 69%; N = 18; n mindfulness = 1,056; n controls = 986. • Hedges' g follow-up = -0.24, 95% CI = -0.54 to 0.06; NS; N = 7. • No adverse events and attrition rates were available.
Chu et al. (2018)	132 (n mindfulness = 73, n controls = 59) bipolar disorder patients (DSM IV or ICD) (39±10years; 56.2% female) in 3 RCTs	Adjunctive mindfulness interventions	• Depressive symptoms: Hedges' g = 0.46, 95% CI = −0.44 to 1.35; p = 0.315; I^2=75%; N = 3; n mindfulness = 73; n controls = 59. • Anxiety: Hedges' g = 0.33, 95% CI = −0.84 to 1.50; p = 0.578; I^2=85%; N = 3; n mindfulness = 73; n controls = 59. • No attrition rates were available for the RCTs. In non – RCTs attrition rates ranged from 8% to 42%. • No adverse events were present in the 3 RCTs.

Table 1. Continued

Reference	Participants	MBIs and control interventions	Effect sizes, adverse events and attrition rates
Goldberg et al. (2018)	13,331 (n mindfulness = 6,825; n controls = 6,506) with a DSM disorder (mean age = 44 years; 64.4% female) in 172 RCTs	Mindfulness vs no, minimal, specific, non-specific and evidence-based conditions	• Mental health improvements (vs. no treatment conditions): Cohen's d = 0.55, 95% CI = 0.47 to 0.63; I^2 = 58%; N = 90; n mindfulness = 2966; n controls = 2,782. • Mental health improvements (vs. minimal treatment conditions): Cohen's = 0.37, 95% CI = 0.03 to 0.71; I^2 = 33%; N = 5; n mindfulness = 311; n controls = 246. • Mental health improvements (vs. non-specific treatment conditions): Cohen's d = 0.35, 95% CI = 0.09 to 0.62; I^2 = 62%; N = 10; n mindfulness = 200; n controls = 210. • Mental health improvements (vs. specific treatment conditions): Cohen's d = 0.23, 95% CI = 0.12 to 0.34; I^2 = 61%; N = 43; n mindfulness = 1,936; n controls = 1,874). • Mental health improvements (vs. other evidence-based treatments): Cohen's d = −0.004, 95% CI = −0.15 to 0.14; I^2 = 65 %; N = 29; n mindfulness = 1,412; n controls = 1,394. • No adverse events and attrition rates were available.
Vollbehr et al. (2018)	major depression, dysthymic disorder, generalized anxiety disorder, social anxiety disorder, or panic disorder (DSM-IV or ICD-10) (78.7% female); n =1,532 in 18 RCTs	Yoga vs. active control conditions (e.g., mindfulness, walking, psychoeducation)	• Depression (vs. all active control conditions): Cohen's d = -0.13, 95% CI = -0.49 to 0.22; p = 0.47; I^2 = 77%; N = 11. • Depression (vs. psychoeducation alone): Cohen's d = -0.52, 95% CI = -0.98 to -0.08; p = 0.02; I^2 = 56%; N = 6. • Depression (vs. treatment as usual): Cohen's d = -0.64, 95% CI = -1.41 to 0.13; p = 0.10; I^2 = 93%; N = 5. • Anxiety (vs. all active control conditions): Cohen's d = -0.09, 95% CI = -0.47 to 0.30; p = 0.65; I^2 = 63%; N = 5. No adverse events and attrition rates were available.
Zhang et al. (2018)	550 with depression (DSM-IV or ICD-10) in 5 RCTs	Mindfulness vs. treatment-as-usual, wait-list, psychoeducation or antidepressant medication	• Relapse prevention in those with 3 or more previous depressive episodes: HR = 0.46, 95%CI = 0.31 to 0.70; p<0.001; I^2 = 38%; N = 5; n = 550. • Relapse prevention vs maintenance antidepressant medication: HR = 0.76, 95% CI = 0.58 to 0.98; p=0.04; I^2 = 0%; N = 3; n = 601. • No adverse events and attrition rates were available.
Grant et al. (2017)	901 (n mindfulness = 425, n controls = 476) with alcohol, opioid, stimulant, and/or cannabis use disorder; diagnoses included abuse or dependence (DSM or ICD) (34-45 years) in 9 RCTs	Mindfulness based relapse prevention vs control conditions	• Relapse: OR = 0.72, 95% CI = 0.46–1.13; N = 7; n = 841; I^2 = 0%, NS. • Frequency of use: SMD = 0.02, 95% CI = -0.40 to 0.44; N=5; n = 718; I^2 = 42%, NS. • Depressive symptoms: SMD = -0.09, 95% CI = -0.39 to 0.21; N = 4; I^2 = 0%; NS. • Anxiety symptoms: SMD = -0.32, 95% CI = -1.16 to 0.52; N = 4; I^2 = 78%; NS. • Withdrawal/craving symptoms: SMD = -0.13, 95% CI= -0.19 to -0.08; N= 5; I^2 = 0%; S. • Based on 3 RCTS only 1 participant reported nightmares, increased anxiety, and trauma memories at a follow-up visit. • Treatment dropout: OR = 0.81, 95% CI = 0.40 to 1.62; NS.
Hopwood et al. (2017)	1,863 diagnosed with PTSD in 17 RCTs	Mindfulness vs. waitlist/non-active control, placebo, or evidence-based treatment of PTSD	• PTSD symptoms (vs. all control conditions): Hedges' g = -0.41, 95% CI = -0.60 to -0.22; p<0.001; N=17. • PTSD symptoms (vs. waitlist): Hedges' g = -0.59, 95% CI = -0.93 to -0.26; p = 0.001 • PTSD symptoms (vs. placebo): Hedges' g = -0.28, 95% CI = -0.52 to -0.04; p = 0.02 • PTSD symptoms (vs. evidence-based treatment): Hedges' g = -0.38, 95% CI = -0.58 to -0.18; p<0.001 • No adverse events and attrition rates were available.

Table 1. Continued

Reference	Participants	MBIs and control interventions	Effect sizes, adverse events and attrition rates
Zheng et al. (2016)	483 (n tai chi = 215, n controls = 268) with schizophrenia (DSM IV, ICD 10 or CCMD 3) (18-65 years; 59.5% male) in 6 RCTs	Tai chi vs. active and passive control conditions	• Negative symptoms: SMD = -0.87, 95% C = -1.51 to -0.24; p = 0.007; I^2 = 90%; N = 6; n tai chi = 200; n controls = 251. • Positive symptoms: SMD= -0.09, 95% CI: -0.44 to 0.26; p=0.60; I^2=65% N = 5; n tai chi = 170; n controls = 221. • No difference in discontinuation rate between tai chi and control groups: RR = 0.57, 95% CI = 0.23 to 1.40; p = 0.22; I^2 = 0%; N = 4, n = 334. • No adverse events were observed in all 6 RCTs.
Cramer et al. (2013)	212 (n yoga = 108, n controls = 104) with schizophrenia (DSM IV, ICD 10 or CCMD 3) (28-48 years; 31 to 60% female) in 5 RCTs	Yoga vs. usual care or exercise	• Quality of life (vs. usual care): SMD = 2.28; 95% CI = 0.42 to 4.14; p = 0.02; I^2 = 89%; N = 2; n yoga = 48; n controls = 50. • Social function (vs. usual care): SMD= 1.20; 95% CI = −0.78 to 3.18; P = 0.23; I^2 = 96%; N = 3; n yoga = 87; n controls = 84. • Positive symptoms (vs. aerobic exercise): SMD = −0.35; 95% CI = −0.75 to 0.05; P = 0.09; I^2=0%; N = 2; n yoga = 60; n controls = 42. • Negative symptoms (vs. aerobic exercise): SMD = −0.28; 95% CI = −1.42 to 0.86; P = 0.63; I^2= 87%; N = 2; n yoga = 60; n controls = 42. • Social function (vs. aerobic exercise): SMD= 0.20; 95% CI = −0.27 to 0.67; P = 0.41; I^2= 27%; N = 2; n yoga = 60; n controls = 42. • No attrition rates were available. • No adverse events were present in 3 RCTs.

CBT = cognitive behavioural therapy; CCMD = Chinese Classification of Mental Disorders; CI= confidence interval; DSM = Diagnostic and Statistical Manual of Mental Disorders; ICD = International Classification of Diseases; NS = non-significant; N = number of trials; n = number of participants; S = significant; PrI = prediction interval

Table 2. Methodological quality of the included meta-analyses

Reference	AMSTAR items											Total score
	1	2	3	4	5	6	7	8	9	10	11	
Jansen et al. (2020)	0	1	1	1	0	1	1	1	1	1	0	8*
Miller et al. (2020)	1	1	1	1	0	1	1	0	1	1	1	9*
Guo et al. (2019)	0	1	1	1	0	1	1	0	1	1	1	8*
Hartley et al. (2019)	1	1	1	1	0	1	1	1	1	1	1	10*
Xue et al. (2019)	0	1	1	1	0	1	1	1	1	1	1	9*
Sabe et al. (2019)	1	1	1	1	0	1	1	0	1	0	1	8*
Vollbehr et al. (2018)	0	1	1	1	0	1	1	0	1	1	1	8*
Chi et al. (2018)	0	1	1	1	0	1	1	1	1	1	0	8*
Chu et al. (2018)	0	1	1	1	0	1	1	0	1	1	1	8*
Cramer et al. (2018)	0	1	1	1	0	1	1	0	1	0	1	7
Goldberg et al. (2018)	0	1	1	1	0	1	1	0	1	1	1	8*
Zhang et al. (2018)	0	1	1	1	0	1	1	0	1	1	1	8*
Kuyken et al. (2018)	0	1	1	1	0	1	1	1	1	0	1	8*
Grant et al. (2017)	1	1	1	1	0	1	1	1	1	1	1	10*
Hopwood et al. (2017)	0	1	1	1	0	1	1	0	1	1	1	8*
Zheng et al. (2016)	0	1	1	1	0	1	1	0	1	1	1	8*
Cramer et al. (2013)	0	1	1	1	0	1	1	0	1	1	1	8*

0 = no; yes; 1 = yes. AMSTAR items, 1 = a-priori design; 2 = duplicated coding for study selection and data extraction; 3 = comprehensive literature search strategy; 4 = consideration of grey literature; 5 = justification of excluded papers; 6 = description of included studies; 7 = scientific quality assessment; 8 = scientific quality consideration; 9 = using appropriate statistical methods;10 = consideration of publication bias; 11 = reporting conflict of interest. The total number of “yes” was summed. *AMSTAR≥8 = high methodological quality.

Table 3. Methodological quality of the included RCTs in the meta-analyses

Reference	AMSTAR Plus Content items						Total score
	1	2	3	4	5	6	
Jansen et al. (2020)	0	2	1	1	0	1	5*
Miller et al. (2020)	0	1	0	1	1	1	4*
Guo et al. (2019)	0	0	0	1	1	1	3
Hartley et al. (2019)	0	0	0	1	1	0	2
Xue et al. (2019)	0	2	0	1	0	1	4*
Sabe et al. (2019)	0	2	1	1	0	0	4*
Vollbehr et al. (2018)	0	0	0	1	1	0	2
Chi et al. (2018)	0	2	1	1	0	0	4*
Chu et al. (2018)	0	0	0	1	0	0	1
Cramer et al. (2018)	0	0	0	1	0	0	1
Goldberg et al. (2018)	0	2	1	1	0	0	4*
Zhang et al. (2018)	0	1	0	1	0	1	3
Kuyken et al. (2018)	0	2	1	1	0	1	5*
Grant et al. (2017)	0	1	1	1	1	0	4*
Hopwood et al. (2017)	0	2	0	1	1	1	5*
Zheng et al. (2016)	0	0	0	1	0	0	1
Cramer et al. (2013)	0	0	0	1	0	0	1

Items 1-3 are scored on a scale from 0 to 2. Items 4-6 are scored with a 0 or 1. AMSTAR Plus Content items, 1 = RCTs double blind; 2 = sample size; 3 = at least one large RCT (≥100); 4 = observed cases; 5 = heterogeneity; 6 = publication bias. *AMSTAR Plus Content ≥4 = high methodological quality.