REVIEW

Economic Evaluations of Mindfulness-Based Interventions: a Systematic Review

Lingling Zhang1 · Snehal Lopes2 · Tara Lavelle3 · Karyn Ogata Jones4 · Liwei Chen5 · Meenu Jindal6,7 · Heidi Zinzow8 · Lu Shi2

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Abstract

Objectives This study includes a systematic review of cost-effectiveness analyses (CEAs) and cost–benefit analyses (CBAs) of mindfulness-based interventions (MBIs).

Methods A literature search was conducted using PubMed, Web of Science, JSTOR, and CINAHL for studies published between January 1985 and September 2021, including an original cost-related evaluation of an MBI. A qualitative assessment of bias was performed using the Drummond checklist.

Results Twenty-eight mindfulness-based intervention studies (18 CEAs and 10 CBAs) were included in this review. Mindfulness-based stress reduction (MBSR) was less costly and more effective when compared with the usual care of cognitive behavioral therapy among patients with chronic lower back pain, fibromyalgia, and breast cancer. MBSR among patients with various physical/mental conditions was associated with reductions in healthcare costs. Mindfulness-based cognitive therapy (MBCT) was also less costly and more effective than the comparison group among patients with depression, medically unexplained symptoms, and multiple sclerosis. MBCT’s cost-effectiveness advantage was also identified among breast cancer patients with persistent pain, non-depressed adults with a history of major depressive disorder episodes, adults diagnosed with ADHD, and all cancer patients. From a societal perspective, the cost-saving property of mindfulness training was evident when used as the treatment of aggressive behaviors among persons with intellectual/developmental disabilities in mental health facilities.

Conclusions Based on this review, more standardized MBI protocols such as MBSR and MBCT compare favorably with usual care in terms of health outcomes and cost-effectiveness. Other MBIs may result in cost savings from both healthcare and societal perspectives among high-risk patient populations.

Keywords Cost-effectiveness analysis · Meditation · Mindfulness · Complementary and alternative medicine

Mindfulness-based interventions (MBIs) aim to develop a nonjudgmental awareness and experiential acceptance of present experiences (Ludwig & Kabat-Zinn, 2008). MBIs have developed over the last 30 years as a lifestyle approach to manage chronic health conditions and avert the negative psychological impacts from a range of medical and psychological disorders (Duarte et al., 2019). Mindfulness-based stress reduction (MBSR; Irving et al., 2019),

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1 Manning College of Nursing and Health Sciences, University of Massachusetts Boston, Boston, MA, USA
2 Department of Public Health Sciences, Clemson University, 500 Edwards Hall, Epsilon Zeta Dr, Clemson, SC 29631, USA
3 Tufts Medical Center Institute for Clinical Research and Health Policy Studies, Tufts University School of Medicine, Boston, MA, USA
4 School of Nursing, Clemson University, Clemson, SC, USA
5 Department of Epidemiology, University of California Los Angeles, Los Angeles, CA, USA
6 Department of Internal Medicine, Prisma Health, Greenville, SC, USA
7 Department of Medicine, School of Medicine Greenville, University of South Carolina, Columbia, SC, USA
8 Department of Psychology, Clemson University, Clemson, SC, USA
2009; Kabat-Zinn, 2009) and mindfulness-based cognitive therapy (MBCT; Teasdale et al., 2000) are commonly used MBIs found to significantly improve outcomes such as depressive symptoms, anxiety, stress, and physical functioning for patients with cancer, chronic pain, cardiovascular disease, somatic diseases, and depression (Duarte et al., 2019). There are other variations of MBIs that have also shown a positive impact on health, such as mindfulness-based positive behavior support training (MBPBS; Singh et al., 2015), meditation on the soles of the feet (a component of MBPBS; Felver & Singh, 2020; Singh et al., 2003), and mindfulness-based art therapy (MBAT; Prioli et al., 2017). With respect to the mental health challenges resulting from the COVID-19 global pandemic (Yao et al., 2020), meditation can serve as a protective factor against psychological distress (Conservsano et al., 2020) and has been associated with more engagement in COVID-19 preventive health behavior (Halawa et al., 2020). In response to social distancing and shelter-in-place pandemic protocols, MBIs have been successfully adapted to a telehealth delivery model (Chadi et al., 2020; Niles et al., 2012).

Most, if not all, health behavior interventions result in costs that must be considered when planning and allocating resources. Therefore, economic evaluations should be performed to understand the cost-effectiveness of alternative therapies such as MBIs (Reeves et al., 2019) to inform health policy, programming, and budget decisions. Such evaluations would help to objectively assess the costs and consequences of an MBI relative to an alternative course of action (Drummond et al., 2015; Duarte et al., 2019). Though several systematic reviews and meta-analyses have demonstrated the overall effectiveness of mindfulness-based training programs (Burton et al., 2017; Li et al., 2017; Xunlin et al., 2020) in improving health-related outcomes, there is a need for a systematic review to summarize and evaluate the evidence on the cost-effectiveness and cost-saving properties for MBIs. Such evidence is important for ensuring that scarce resources are allocated to health interventions that return value for money (Duarte et al., 2019).

The aim of this study was to synthesize the existing evidence on the economic evaluations of MBIs by providing a systematic review of cost-effectiveness analyses (CEAs) and cost–benefit analyses (CBAs) of MBIs. The results from this study can help insurers, administrators, providers, employers, and patients to make more strategic and informed decisions related to using or enrolling in any specific types of MBIs with respect to patient conditions and needs, as well as assisting providers in anticipating and planning for costs for training and certification of MBIs.

**Methods**

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2010). Four databases (PubMed, Web of Science, JSTOR, and CINAHL) were systematically searched for studies between January 1985 and September 2021 that matched English search terms in both cost analysis (i.e., cost-effectiveness, cost–benefit, cost-reduction, cost-utility, economic evaluation) and MBIs (i.e., meditation, mindfulness). A manual search of the references of the reviewed studies was also conducted.

Studies with standard economic evaluation designs were searched for, including CEA and CBA (Atusingwize et al., 2015). The included studies were conducted from a variety of perspectives, such as societal (Jönsson, 2009), healthcare (Kunz et al., 2016), payer (Sørensen et al., 2011), provider (Navas et al., 2007), government (Einarson et al., 1994), and employer (Grimani et al., 2018) perspectives. In the review, CEA refers to the evaluation of the effectiveness of two or more interventions relative to their cost, where benefits are measured in non-monetary units (e.g., life years gained) to obtain an incremental cost-effectiveness ratios (ICERs: defined as the ratio of the additional costs per unit of incremental benefit of an intervention; York Health Economics Consortium, 2016). A CEA enables comparison between interventions by estimating the cost for achieving a unit gain of a health outcome, for example, a life year gained (Centers for Disease Control & Prevention, 2021). When quality-adjusted life years (QALYs) are used as a CEA outcome measure, a cost per QALY is calculated (Raisch, 2000). CBA refers to the studies about the cost outcome for the healthcare system and/or the society (through reducing productivity loss, employee turnover, etc.) following the “human capital” approach of defining cost–benefit analyses (Colombo et al., 2006; Robinson, 1993).

Studies were included in this review if they (1) reported original cost-related analysis, and (2) included an evaluation of an MBI. Conference proceedings, letters to the editor, commentaries, other review studies, studies where the meditation component was mixed with other types of interventions, cost analysis studies without outcomes, and studies where the effectiveness outcome was not health related were excluded.

Data extraction, quality assessment, and evaluation of indirectness (Schünemann et al., 2020) in outcome measures were performed by the lead reviewer and validated by a second reviewer. Any disagreement was resolved through a discussion between the two reviewers to achieve a consensus or by consulting a third reviewer. Data extraction included the following characteristics of each study: study...
population, type of intervention, comparator, effectiveness data (CEA studies), measure of benefit (CBA studies), cost data, discounting, time horizon, study perspective, sensitivity analyses, and results. All monetary values reported were converted to 2020 US dollars to allow the comparison of results across studies. Quality assessment was conducted using the Drummond 10-point checklist (Drummond et al., 2015), a concise tool for assessing the quality and possible biases of empirical studies (Atusingwize et al., 2015). The studies were evaluated to check whether they used proxy or surrogate measures when reporting their intervention outcomes (Schünemann et al., 2020). This systematic review was not prospectively registered.

Results

The database search yielded 1329 relevant articles. One additional study was identified through manual search of the references of the included studies. After screening titles and abstracts, 1273 articles were excluded, leaving 58 articles for full-text reviews. Sixteen articles were excluded after the initial full-text review, including one conference proceeding, one correspondence article, and 14 articles without cost analyses of MBIs. Two articles (van Ravesteijn, 2016; van Ravesteijn et al., 2013) were considered a duplication since they were based on the same study. Thus, there were 41 studies included at this stage. At the final level of review for inclusion, 13 additional studies were excluded because the meditation component was mixed with other types of interventions (D’Amico et al., 2020; Doyle et al., 2019; Gapp et al., 2020; Ljóttsson et al., 2011, 2014; Mercer et al., 2016; Orme-Johnson & Herron, 1997; Stahl et al., 2015; Sun et al., 2021), they were feasibility studies with only intervention costs (Hennelly et al., 2020; Tulloh et al., 2018), the effectiveness outcome included for cost-effectiveness calculation was not a health-related outcome (e.g., teaching competency as the effectiveness outcome; Crane et al., 2020), or the meditation intervention was not an MBI (Herron, 2011), leaving 28 studies meeting the criteria to be included in this study (Fig. 1).

About the specific types of MBIs included in the study, MBSR (Irving et al., 2009; Kabat-Zinn, 2009), MBCT (Teasdale et al., 2000), MBPBS (Singh et al., 2015), meditation on the soles of the feet (Singh et al., 2003), MBAT (Prioli et al., 2017), and non-standarded formats of MBIs (Müller et al., 2019; Saha et al., 2020; van Dongen et al., 2016) were presented in the analyses.

Characteristics of the Studies

Tables 1 and 3 report the key characteristics of the included studies. The 28 articles were divided into two categories: (1) CEA studies (n = 18) that addressed both cost (direct costs and/or indirect costs) and treatment effectiveness outcomes (Table 1); and (2) CBA studies (n = 10) that focused on cost outcomes (direct costs and/or indirect costs) (Table 3). The studies included were based in nine countries: USA (n = 11), Netherlands (n = 5), UK (n = 4), Canada (n = 2), Denmark (n = 2), Sweden (n = 1), Spain (n = 1), Australia (n = 1), and Germany (n = 1). The types of interventions in the reviewed studies included MBCT (n = 10), MBSR (n = 5), MBPBS (n = 4), meditation on the soles of the feet (n = 1), MBAT (n = 1), and other MBIs (n = 7). The study design included randomized controlled trials (RCTs) (n = 17), quasi-experimental studies (n = 4), multiple baseline design studies (n = 2), observational studies (n = 2), and simulation studies (n = 3).

Cost-effectiveness Analyses (CEAs)

Table 1 reports the findings on interventions that were both clinically effective and cost saving. To summarize, MBCT for the following types of patients had the cost-saving property in addition to effectiveness: (1) individuals with a history of major depressive disorder episodes (Pahlevan et al., 2020; Shawyer et al., 2016); (2) women with breast cancer and persistent pain (Johannsen et al., 2017); (3) multiple sclerosis patients (Bogosian et al., 2015); and (4) Parkinson’s disease patients (Bogosian et al., 2021). In addition, for patients with chronic lower back pain, the standardized protocol of MBSR also had the property of cost saving plus its effectiveness advantage as compared with the usual care of cognitive behavioral therapy (Herman et al., 2017).

Cost-effectiveness thresholds vary among countries and other entities, as these variations reflect the highest financial amount that a payer entity is willing to pay for an additional QALY. MBSR among women with breast cancer versus usual care was an illustration of interventions that improved effectiveness, but increased cost, which resulted in the cost per QALY gained of $19,733 (equivalent to $23,058 in 2020) for patients and $22,200 (equivalent to $25,941 in 2020) as compared to usual care (Lengacher et al., 2015). These values fell well below the cost-effectiveness threshold of $100 K/QALY gained (Neumann et al., 2014). For patients with medically unexplained symptoms, MBCT’s ICER as compared with enhanced usual care was 56,637 Euro, equivalent to $99,818 in 2020 per QALY gained (van Ravesteijn, 2016; van Ravesteijn et al., 2013) which fell just slightly below the threshold (Neumann et al., 2014), and £27,107 (equivalent to $40,872 in 2020) as compared to usual care (Bogosian et al., 2021).

No effectiveness advantage was documented for mindfulness group therapy using a non-standardized protocol (Bogosian et al., 2015). Saha et al. (2020) showed that mindfulness group therapy had a considerable probability of
being cost-effective (67% from the societal perspective and 70% from the healthcare perspective) among adult patients with depression, anxiety or stress, and adjustment disorder as compared with usual care. Economic evaluations of less common mindfulness intervention protocols did not find the programs to be more effective or cost-effective than controls, for example, MBAT among breast cancer patients (Prioli et al., 2017) and worksite MBIs among government employees (van Dongen et al., 2016).

When costs are measured from a healthcare perspective in terms of adverse episodes averted among patients with recurrent depression, MBCT with support to taper off/stop antidepressant medication (MBCT-TS) saved $439 (equivalent to $673 in 2020) per relapse averted and $23 (equivalent to $35 in 2020) per disease-free day gained, as compared with maintenance-antidepressant medication treatment (m-ADM; Kuyken et al., 2008). This result compared favorably with the ICER of popular adjunctive therapies such as cognitive therapy (Scott et al., 2003) in depression care. However, when Kuyken et al. (2015) further tested the effectiveness and cost-effectiveness of MBCT-TS among patients with three or more major depressive disorder episodes and on prescribed medication, they found that MBCT-TS was neither more effective nor more cost-effective compared with m-ADM, though both MBCT-TS and m-ADM had enduring effectiveness.

The CEA studies included a broad variety of interventions and used different measures of costs and effectiveness.
Table 1 Cost-effectiveness analyses

| Author, year, country | Study population | Study design/blinding procedures | Intervention | Comparator | Effectiveness data | Measures of benefit | Perspective/time | Cost data included in the analysis | Cost currency/year | Sensitivity analyses | Results (USD in 2020) |
|-----------------------|------------------|----------------------------------|--------------|------------|-------------------|-------------------|-----------------|-----------------------------------|------------------|-------------------|------------------------|
| Sawyer et al., 2016, Australia | Non-depressed adults with a history of three or more depressive episodes | RCT/no blinding | MBCT—8 session, 2 h each, 6 session/week, w/ optional sessions at 3-month intervals and relapse monitoring | Depressive relapse active monitoring | Effect of treatment was measured from an RCT using the WHO CIDI question | DALYS | Societal and health care system/2 years | Health care costs (physician, hospitalization, pharmacy, cures from productivity losses due to illness | The 2015 Euro/no discounting | SAs were conducted using bootstrap methods | In 2 perspectives, MBCT was cost saving compared to UC (lower costs, higher health gains). Incremental gain per DALY for MBCT was AUD113,541 (USD101,080) not below willingness to pay threshold of AUD113,541 (USD101,080) in the payer perspective. |
| Johannessen et al., 2017, Denmark | Women with primary breast cancer and persistent pain | RCT/no blinding | MBCT—8 session, 2 h each, 1 session/week, with higher value confidence | No intervention (“wait-list”) | Pain intensity (minimum clinically important difference (MCID)) | Number of patients who achieved MCID in pain intensity | Health care system/months | Health care service utilization, medication costs, intervention delivery costs (materials and salaries of personnel) | The 2015 Euro/no discounting | SAs assessed effects of higher program cost and imputed values | MBCT group had a 720,000 USD lower cost per participant and 2.71 higher odds of achieving MCID in pain intensity, than control group. |
| Bogosian et al., 2015, UK | Patients with multiple sclerosis (MS) | RCT/no blinding | eMBCT, sessions, 1 h, each, 1 session/week, via Skype video conference | No intervention (“wait-list”) | General health, hospital anxiety and depression scale, EQ-5D | Disutility/fatigue/ anxiety/depression/ MS impact/ QALY | Societal/20 weeks from baseline | Service use and costs (including hospital, community, social care, and informal caregiver services), intervention costs (including materials, time spent by therapists) | The 2012–2013 GBP/1 year | Interventions were done to assess the impact of imputation on missing baseline variables | MBCT group cost less, had better outcomes (e.g., lower distress), was cost saving with an 85% probability of being cost-effective at a threshold of 20,000 GBP (USD37,964) |
| Herman et al., 2017, Denmark | Patients with chronic lower back pain | RCT/no blinding | MBCT, 8 sessions, 2 h each, 1 session/week, w/ optional session at 3-month intervals and relapse monitoring | CBT/behavioral therapy (CBT) | Effect was measured using SF-6D scores | QALYS | Societal and health plan (payer)/year | Intervention cost, health plan reimbursed costs for healthcare, absenteeism and presenteeism at work due to lower back pain | The 2013 US $/no discounting | SAs were done to assess the impact of imputation on missing baseline variables | MBCT group cost less, had better outcomes (e.g., lower distress), was cost saving with an 85% probability of being cost-effective at a threshold of 20,000 USD (USD945) lower cost per participant and 2.71 higher odds of achieving MCID in pain intensity, than control group. |
| Hallgren et al., 2020, USA | Patients with chronic lower back pain | RCT/no blinding | MBCT, 8 weeks | m-ADM | EQ-5D scores from other studies used to calculate QALY scores | Improved QALYS over 2-month period | Healthcare and societal perspective/24 months | Cost of the intervention, maintenance antidepressant medication, health care cost related to relapse, productivity costs | Canadian dollar (2018) | (1) Probabilistic sensitivity analysis; (2) one-way sensitivity analysis; (3) variations in health care perspective and assuming 60% adherence probability for both groups | MBCT had less cost (-7,367) [USD1191] for societal, -992 [USD1191] for payer) and gain in QALYS (0.14) than UC. MBCT had a 96% chance of less than $50,000/QALY (USD65,640/QALY), was cost-effective, could save costs. |
| Palhovian et al., 2020, USA | Adults (18–65 years) with a history of two or more past episodes of MDE, in remission | Simulation study — meta-analysis/not applicable | MBCT, 8 weeks | m-ADM | EQ-SD scores from other studies used to calculate QALY scores | Improved QALYS over 2-month period | Healthcare and societal perspective/24 months | Cost of the intervention, maintenance antidepressant medication, health care cost related to relapse, productivity costs | Canadian dollar (2018) | (1) Probabilistic sensitivity analysis; (2) one-way sensitivity analysis; (3) variations in health care perspective and assuming 60% adherence probability for both groups | MBCT was cost-effective using a threshold of $50,000/QALY (USD65,640/QALY) |
| Longmore et al., 2015, Canada | Women with breast cancer | RCT/no blinding | MBCT—4 sessions, 2 h each, 1 session/week | UC | Effect was measured from an RCT using the SF-12v1 | QALYS | Societal/12 weeks | Intervention costs to the provider: personal time, materials, environment. Interactions with the patient: travel time, transportation costs, childcare costs, lodging, lost wages due to time spent in the intervention | The 2009 Australian dollar/1 year | Not specified/discounting 3% for SAAs | SAs were done by varying efficacy and cost |
| van Ravesteijn et al., 2014 and van Ravesteijn et al., 2016, Netherlands | Women with medically unexplained symptoms | RCT/no blinding | MBCT—4 sessions, 2.5 h each | EUC | Effect of treatment was measured by an RCT using SF-36 | QALYS | Societal/1 year | Employment participation, health care use (including intervention cost) | The 2010 Euro/no discounting | SAs tested impact of the societal vs. healthcare perspective | Compared w/EUC, MBCT was more costly and more effective, with an ICER of 86,670 Euro (USD98,018) per QALY gained (compared to SAAs). |
| Author, year, country | Study population | Study design/blinding procedures | Intervention | Comparator | Effectiveness data | Measures of benefit | Perspective/time | Cost data included in the perspective | Cost currency/year | Sensitivity analyses | Results (USD in 2020) |
|----------------------|-----------------|---------------------------------|--------------|------------|-------------------|-----------------|----------------|----------------------------------------|-----------------|-------------------|------------------------|
| Kuyken et al., 2008, UK | Patients with recurrent depression | RCT/Assessor blinding | MBCT—8 sessions w/ support to taper or stop antidepressant medication | m-ADM | Primary outcome: time to relapse or recurrence of depression | Number of depression relapse/recurrences averted, depression-free days (DFD) | Societal and health care system/15 months | Costs of the intervention, productivity losses (individual’s salary) days off work due to illness, hospital, community health and social services used | The 2006 US $ | Probabilistic sensitivity analyses were conducted using bootstrapping methods | The ICER of MBCT over m-ADM was $962 (USD1476) per relapse prevented and $50 (USD77) per DFD (societal). ICER of MBCT over m-ADM was $439 (USD673) per relapse averted and $23/DFD (USD35/DFD) (healthcare) |
| Saha et al., 2020, Sweden | Adult patients with depression, anxiety or stress and adjustment disorder | RCT/No blinding | Based on MBSR + MBCT, 8 sessions, 2 h each, 1 session/week | UC (pharmacological treatment often accompanied by psychotherapy or counseling) | Quality of life measured using the EQ-5D-5L questionnaire | Improved QALYs at 8 weeks post-intervention follow-up as compared to baseline | Healthcare and societal perspective/8 weeks | Intervention cost, medication, healthcare visits for usual care and productivity costs | EUR (2012) (converted from Swedish Kroner SEK 2012) | (1) Multiple imputation for missing QALY or cost data; (2) excluding outliers; (3) accounting for attendance | The intervention had €115 (USD184) less healthcare cost and €112 (USD179) less societal costs than UC. No notable difference in QALY. At threshold of €24,691/QALY (USD39,457 QALY), MBCT’s probability to be cost-effective is 67% (societal) and 70% (healthcare) |
| Kuyken et al., 2015, UK | Patients with recurrent major depression disorder | RCT/Participants blinded | MBCT: 8 sessions, 2.5 h each, 1 session/week, w/ 4 refresher sessions for 1 year + tapering support | m-ADM | Primary outcome: time to relapse. Secondary: outcomes: depression-free days, quality-of-life, etc | Number of depression relapse/recurrence averted, number of depression-free days, and QALYs | Societal and health care system/2 years | Costs of the intervention, productivity losses, medications, other healthcare, and social services used | The 2011–2012 GBP (discounting rate: 3.5%) | Probabilistic sensitivity analyses were conducted using bootstrapping methods | From either societal or healthcare system perspective, there was no evidence that MBCT is more cost-effective than m-ADM, in terms of either relapse or recurrence or QALYs |
| Prioli et al., 2017, USA | Women with breast cancer | Secondary data analysis, Quasi-experiments/not applicable | MBAT—8 2.5-h sessions, 1 session/week | Breast cancer support group (BCSG) | SF-36 | QALYs | Health care system/9 weeks | Direct costs related to intervention delivery (including travel costs for patients and providers), costs of other medical services and/or medications used by the participants | The 2011 US dollar (discounting) | SAs were conducted by varying the cost of intervention components | MBAT was $429.78 (USD554) more costly than BCSG. Both achieved similar changes in health-related utility. SAs show MBAT can be cost saving compared to BCSG |
| Study                          | Population                             | Design                          | Interventions                                                                 | Outcome Measures                                                                 | Perspective     | Year of publication | Costs and effectiveness |
|-------------------------------|----------------------------------------|---------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----------------|---------------------|-------------------------|
| van Dongen et al., 2016, Netherlands | Employees of two Dutch government research institutes | RCT/no blinding | Worksite mindfulness intervention—8 sessions, 1 session/week, information about other health promotion activities | Information about other health promotion activities in their workplace, work engagement, general vitality, job satisfaction, and work ability | Societal and Employed/12 months | The 2011 Euros, no discounting | No significant between-group differences on job satisfaction, general vitality, and work ability. The maximum probability of cost-effectiveness was very low for all outcome, irrespective of the willingness-to-pay (0.25). Control group had more work satisfaction. |
| Compen et al., 2020, Netherlands | All types of cancer patients            | RCT/no blinding | (1) MBCT, (2) eMBCT 8 sessions, 2.5 h each session, 1 session/week            | UC EQ-5D-3L utility scores, Improved QALY's, Societal perspective/3 months | Healthcare costs including prescriptions, formal and informal productivity costs, intervention costs | EUR (2016) | None | Effect is insignificant in both interventions (compared to controls). Lower costs for MBCT and eMBCT (compared to controls). Incremental monetary benefit over control group = €1916 (USD2358) for MBCT and €2365 (USD2911) for eMBCT. 99% chance to be cost-effective. |
| Müller et al., 2019, Germany | Adult covered under German Insurance fund AOK Baden-Württemberg | Observational study with propensity score matching/not applicable | “Life Balance”, an MBI. 6 weekly sessions, one session per week, 1.5 h each and 1 additional session a month after completion of the 6 weeks sessions | UC Hospital Anxiety and Depression Scale (HADS) score, Improvement in mental health as measured by the HADS | Healthcare and Societal perspective/12 months | Healthcare costs covered by the insurance agency and lost work days, intervention costs | EUR (2014–2015, no adjustment for time difference) | From societal perspective, intervention has lower costs (€-57) (USD74) and higher effectiveness (1.97 HADS units), was cost-effective (ICER=€-29 (USD38) per HADS unit). From healthcare perspective, intervention has higher costs (€138) (USD174) and had ICER=€91 (USD115) per HADS unit. |
| Study                        | Location         | Setting                          | Type                     | CBT/Clinical outcomes | Intervention Description                                                                 | Outcomes Measures                                                                 | Perspective                                                | Costs and ICER                                                                 |
|------------------------------|------------------|----------------------------------|--------------------------|------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------|
| Janssens et al., 2019,       | Netherlands      | Adults diagnosed with ADHD       | RCT/clinical outcomes    | MBCT + UC              | MBCT was 8-week intervention, 2.5 h each session, and a 6-h silent day                    | Improvement in QALYs measured using SF-12, (2) ADHD symptoms measured using DSM-IV criteria | Societal and healthcare perspective over 9 months | Healthcare costs (including intervention costs), productivity loss costs |
| Pérez-Aranda et al., 2019,   | Spain            | Adults with a diagnosis of fibromyalgia | Quasi-experimental/ not applicable | MBCT—8 sessions, 2 h each, one session/week, and a 6-h silent retreat between week 6 and 7 | (1) FibroQoL program (similar to MBCT but without mindfulness component); (2) UC (no active treatment with usual medications if any) | Improvement in QALYs and visual analogue scale (EQ VAS) score | Health care perspective over 12 months | EUR (2016) Imputating missing data with last observation carried forward and multiple imputation; (2) exclude cost outliers; (3) intention to treat and per protocol analysis |
| Herman et al., 2020, USA     | Adults (young and middle aged) with chronic lower back pain | Markov simulation to secondary effectiveness data | Markov simulation to secondary effectiveness data | MBCT (8 sessions, 2 h each, 1 session/week, and an optional 6 h retreat) | UC QALYs calculated by the Markov model using secondary effectiveness data | Improvement in QALYs | Societal and payer perspective over 1 year | Healthcare and productivity costs |
|                             | Compared with UC, MBSR had lower costs from societal (−$180) (− USD 210) and payer (−$52) (− USD 61) perspectives, and higher QALYs (0.007). MBSR was cost-effective (below $50,000 USD 58,426/ QALY threshold). QALY gains and cost saving for MBSR were higher when all patients were assumed to have high-impact chronic pain. |
Therefore, it was not possible to statistically compare the results across studies. Instead, to categorically assess the studies, a matrix was created where individual studies were classified based on their findings as follows: (1) cost-effective, results under the threshold of $100 K/QALY or with a higher probability of increased willingness to pay \( (n = 9) \); (2) cost saving, i.e., an intervention with less costs than the comparison group with greater or equal effectiveness \( (n = 6) \); and (3) neither, interventions that reported non-statistically significant results or results with higher cost and lower benefit \( (n = 3) \). The reviewed studies are classified accordingly in Table 2.

**Cost–Benefit Analyses (CBAs)**

The reviewed cost analyses included studies on caregivers \( (n = 4) \), patients \( (n = 3) \), professional caregivers of adult patients with mild intellectual disabilities \( (n = 1) \), high-cost insurance enrollees \( (n = 1) \), and employees of a large university \( (n = 1) \) (Table 3). The cost-saving property of mindfulness training was most salient when applied to societal outcomes. In particular, MBIs for aggressive behavior among individuals with intellectual/developmental disabilities in mental healthcare facilities resulted in reduced caregiver stress, injuries, and turnover (Singh et al., 2015, 2016a, b). Net savings between $12,051 and $14,820 per caregiver were achieved (Singh et al., 2015, 2016a, b). In considering additional cost benefits from the societal perspective, MBIs have demonstrated reductions in disability pensions in a Danish sample (Fjorback et al., 2013) and reduction in missed days of work in a sample of older adults with multiple respiratory infections (Rakel et al., 2013). From the healthcare perspective, findings were mixed. A Canadian study showed that MBSR among patients with multiple physical and/or mental health conditions (Knight et al., 2015) led to reductions in healthcare costs when compared to no intervention. In contrast, a study of US university employees found no relative cost differences between MBI participants and matched controls, a result attributed to fewer primary care visits but higher prescription drug costs (Klatt et al., 2016).

**Quality Assessment and Evaluation of Indirectness of Outcome Measures**

Results of the quality assessment of studies are presented in Table 4. Studies were rated as follows: having defined their research questions appropriately \( (n = 24) \); having clear and comprehensive description of competing alternatives \( (n = 22) \); and having identified important and relevant costs and (for CEA studies only) consequences for each alternative
While most of the reviewed studies provided either the societal or healthcare viewpoint and all had operating costs, few included capital and operating costs \((n = 2)\) (Kuyken et al., 2008; van Dongen et al., 2016). Most studies included appropriate and accurate measurements for outcomes \((n = 21)\) and credible valuation of costs (for CEA studies only) and consequences \((n = 21)\), as well as covered issues of concern to user satisfaction in their presentation and discussion of results \((n = 19)\).

Among studies with a time horizon of at least 1 year for costs, three adjusted for differential timing and provided information on, and justification for, the discount rate used. The quality assessment of the CEA studies indicated that most studies established effectiveness of MBI at improving health outcomes \((n = 16)\), calculated ICERs taking into account both costs and consequences to compare between the alternative treatments \((n = 17)\), and adequately characterized uncertainty in the estimates of costs (for CEA studies only) and consequences \((n = 23)\).

### Discussion

This systematic review summarized the cost-effectiveness and cost-saving properties of 28 economic evaluations of MBIs, with a notable variety in study populations, types of MBIs, and measures and outcomes reported. Study participants included adult caregivers, specific insurance enrollees, and those with a broad range of physical, behavioral, or mental health conditions. The time horizon of MBIs varied from 8 weeks to 2 years. With few exceptions, the results of this review showed that MBIs were generally cost-effective and/or cost saving in comparison with other treatments (usual care or other non-MBI treatments), at least in the short term (< 5 years). The standardized protocols of MBSR and MBCT indicated robust empirical evidence for their cost-effective properties—a pattern consistent across different patient groups and countries. The most favorable outcomes, i.e., interventions that achieved both cost-effectiveness and cost savings, were noted for the following: (1) MBSR, for women with breast cancer (Lengacher et al., 2015), patients with chronic lower back pain (Herman et al., 2017, 2020), and patients with fibromyalgia (Pérez-Aranda et al., 2019); (2) MBCT, for patients with depression (Kuyken et al., 2008), patients with medically unexplained symptoms (van Ravesteijn, 2016; van Ravesteijn et al., 2013), patients with multiple sclerosis (Bogosian et al., 2015), women with primary breast cancer and persistent pain (Johannsen et al., 2017), non-depressed adults with a history of major depressive episodes (Pahlevan et al., 2020; Shawyer et al., 2016), adults diagnosed with ADHD (Janssen et al., 2019), and all types of cancer patients (Compen et al., 2020); and (3) other MBIs, for adults with national insurance (Müller et al., 2019).

Additionally, the cost-effectiveness advantages of MBIs were found to be most salient among participants with mental health challenges (Janssen et al., 2019; Kuyken et al., 2008; Pahlevan et al., 2020; Saha et al., 2020; Shawyer et al., 2016), breast cancer (Johannsen et al., 2017; Lengacher et al., 2015), lower back pain (Herman et al., 2017, 2020), fibromyalgia (Pérez-Aranda et al., 2019), and multiple sclerosis (Bogosian et al., 2015) with the comorbidity of pain. Among the CBAs reviewed, MBPBS for professional caregivers of persons with intellectual and developmental disabilities (Singh et al., 2008, 2015, 2016a, b, 2020) was found to have a net economic benefit, from both the healthcare and societal perspectives. When delivered to people with various physical/mental health conditions (Knight et al., 2015) or somatization disorder and functional somatic syndromes (Fjorback et al., 2013), MBIs were found to achieve cost savings from the healthcare perspective. For adults with acute infection episodes (Rakel et al., 2013) and non-clinical employees (Klatt et al., 2016), findings were inconclusive related to the cost/cost-effectiveness of MBIs reported. It is important to note that MBIs’ observed cost-effectiveness among patients with pain due to certain chronic diseases may not be generalizable for MBIs’ cost-effectiveness among all patients with chronic diseases since pain reduction is a specific outcome where MBIs have more evidential support compared

| Table 2 Matrix of cost-effectiveness analyses’ findings (results were not limited by the threshold of 100 K per QALY but with other denominators): intervention vs. comparator | Cost-effective | Cost saving | Neither |
|---|---|---|---|
| MBSR | Lengacher et al., 2015 | Herman et al., 2017 |
|  | Pérez-Aranda et al., 2019 |  |
|  | Herman et al., 2020 |  |
| MBCT | Kuyken et al., 2008 | Bogosian et al., 2015 |
|  | van Ravesteijn et al., 2013 & van Ravesteijn, 2016 | Johannsen et al., 2017 |
|  | Janssen et al., 2019 | Shawyer et al., 2016 |
|  | Pahlevan et al., 2020 | Compen et al., 2020 |
|  | Bogosian et al., 2021 |  |
| Other MBIs | Müller et al., 2019 | Saha et al., 2020 |
|  |  | Prioli et al., 2017 |
|  |  | van Dongen et al., 2016 |
| Author, year, country | Study population | Study design/blinding procedures | Intervention | Comparator | Perspective/time horizon | Cost data included in the perspective | Currency/year/discount | Results |
|-----------------------|------------------|--------------------------------|--------------|------------|--------------------------|--------------------------------------|------------------------|---------|
| Singh et al., 2016b, USA | Formal caregivers for those w/ IDD | RCT/no blinding | MBPBS | Training as usual (TAU) | Societal/40 weeks | Costs borne by the agency and workers' compensation due to lost workdays due to injury, 1:1 patient-staff ratio, treatment for staff injuries, staff resigning, hiring temporary staff, staff required for training for the interventions | Not specified/no discounting | Compared to TAU, MBPBS was cost saving (through a reduction of aggressive events): net saving of $457,920 for 38 caregivers receiving MBPBS (~$12,051 per person in 40 weeks) |
| Singh et al., 2008, USA | Offenders with mild IDD in a forensic mental health facility | Multiple baseline design/not applicable | Meditation on soles of feet (30-min 1-on-1, 2/day, 5 d/wk, 27mon) | None | Societal/costs during 12 months prior and 12 months post intervention were analyzed | Medical care for injury of staff providing care to inmates, absenteeism, salary/worker compensation. Costs of training staff for intervention were not included | Not specified | The costs during a 12-month period following intervention decreased by 95.7% compared to the 12 months prior to intervention, a net saving of $50,346 ($8391 per participant) |
| Singh et al., 2015, USA | Formal caregivers of group homes for adults w/ IDD | Multiple baseline design/not applicable | MBPBS | None | Societal/from pre-MBPBS 40 weeks vs. 40 weeks after MBPBS begins | Cost of staff medical care due to injury, lost staff work days and staff turnover related to injury, new employee training and MBPBS training cost (costs for usual standard of care not included) | Not specified | The costs in 40 weeks during MBPBS decreased cost by 87.25% compared to the 40 weeks prior to intervention, a net reduction of $133,380.00 ($14,820/trainee) |

Table 3 Cost–benefit analyses
Table 3 (continued)

| Author, year, country | Study population | Study design/blinding procedures | Intervention | Comparator | Perspective/time horizon | Cost data included in the perspective | Currency/year/discount | Results |
|-----------------------|------------------|----------------------------------|--------------|------------|--------------------------|--------------------------------------|--------------------------|---------|
| Singh et al., 2016a, USA | Formal caregivers from group homes giving service to adults w/ IDD | Quasi-experimental (1 group pretest-posttest)/not applicable | MBPBS | None | Societal/40 weeks | Cost of staff medical care due to injury, lost staff work days and staff turnover related to injury, new employee training and MBPBS training cost (costs incurred by both, the service provider or by the State Worker’s Compensation were included) | Not specified | Cost in 40 weeks during MBPBS decreased by 89.27% compared to the 40 weeks prior to intervention (a net saving of $447,372.00 for the provider, $13,555/trainee) |
| Fjorback et al., 2013, Denmark | Patients w/ somatization disorder and functional somatic syndromes (bodily distress syndrome) | RCT/no blinding | Mindfulness therapy (8 sessions, 3.5 h each, 1 session/week, 1 follow-up session) | EUC | Societal/15 months; healthcare/1 year | Costs included direct healthcare costs (e.g., costs of mindfulness therapy or EUC, hospitalization, etc.) and indirect costs (e.g., disability pension) | The 2007 US$ | Fewer in the therapy group (25%) got disability pension vs. ETAU (45%) at the 15-month follow-up. Care utilization was reduced in both groups from the year before |
| Knight et al., 2015, Canada | Patients with various physical/mental health conditions | Observational (prospective)/not applicable | MBSR (10-week, 9 3-h sessions, and one 7-h session) | No intervention control group | Healthcare perspective/from 1- and 2-year periods prior to MBSR to 1- and 2-yr periods after | Costs included physician-provided services, emergency department and inpatient costs | Not specified | MBSR reduced cost at 1-year pre/post intervention period ($250/person). The gap disappeared at the 2-year pre/post interval w/the exception of laboratory utilization |
| Author, year, country | Study population | Study design/blind- ing procedures | Intervention | Comparator | Perspective/time horizon | Cost data included in the perspective | Currency/year/ discount | Results |
|-----------------------|------------------|-----------------------------------|--------------|------------|-------------------------|-------------------------------------|--------------------------|---------|
| Rakel et al., 2013, USA | Adults 50+ reporting ≥ 1 acute respiratory infection episode/year | RCT/Assessor blinding | Mindfulness meditation: 8 2.5-h classes, 1 session/week | Moderate intensity exercise group and waitlist control group | Societal/costs in the 14 weeks following the intervention were analyzed | Costs included costs related to healthcare visits and medications for acute respiratory infection, and cost from lost work time | Not specified | Total cost/person for the control group: $214, exercise group: $136, mediation group: $65. Cost saving was through reducing missed work days and was offset by the intervention ($450 per person) |
| Klatt et al., 2016, USA | Employees of a large university | Quasi-experimental with matched controls/not applicable | MBI—8 sessions, 1 h each, 1 session/week | Matched controls from non-participants | Healthcare/5 years pre/post intervention period | Healthcare costs included all inpatient, outpatient, laboratory and pharmacy costs | Not specified | MBI group had lower healthcare cost than controls (without statistical significance). MBI group had more prescription drug cost and less primary care visits |
| Singh et al., 2020, USA | Formal caregivers for institutionalized individuals with intellectual and developmental disabilities | RCT/no blinding | MBPBS | PBS | Provider perspective/40 weeks | Costs related to absenteeism, additional temporary or permanent staffing, healthcare for worksite injuries, intervention costs | US$, year not identified/no discounting reported | The costs incurred for MBPBS ($21,000) were higher than PBS ($7000). However, total additional cost was $119,122 for MBPBS and $631,540 for PBS resulting in an overall cost saving of $512,418 for MBPBS as compared to PBS |
with MBIs’ impact on chronic disease management in general (Hilton et al., 2017).

It is also worth noting the extent to which cost-effectiveness may vary depending on the “usual care” comparator programs’ cost volume. For example, in one study (Lengacher et al., 2015), the cost of the MBSR program to improve the QALY among breast cancer survivors comprised less than 1% of direct medical costs, whereas in another study (Fjorback et al., 2013), the MBI delivered to patients with somatization disorder and functional somatic syndromes was 5–6 times more expensive than the cost of usual care for these patients.

Although the heterogeneity in MBIs’ delivery formats, as implemented to meet the needs of vastly different populations, presented a challenge for conducting a meta-analysis of these included studies, it highlighted the utility of MBIs as being adaptable, effective, and accessible to a variety of populations. Furthermore, the findings of this study underscored the potential positive impact of MBIs on population health, especially in systems with limited resources. This review confirmed prior findings that mindfulness training is a well-established, low-cost, and scalable intervention, and can serve as an effective therapeutic treatment with relatively few adverse effects reported (Greenlee et al., 2017).

Limitations and Future Research

More research is needed to understand the long-term effectiveness of MBIs (i.e., more than 5 years). More cost-effectiveness and cost–benefit analyses for other standardized MBIs, such as mindfulness-oriented recovery enhancement (MORE; Garland et al., 2014) and mindfulness-based relapse prevention (MBRP; Witkiewitz et al., 2013), are also needed.

The absence of studies from Asia, Africa, and Latin America may have been impacted by the search strategy used in this study (database searches only conducted with English keywords), or the fact that MBIs (and the resulting academic reporting) may not be widely implemented and/or evaluated yet in these regions. The studies that met the inclusion criteria in this study were conducted in middle- and high-income countries with generally higher per capita incomes. Given the cost-effectiveness and cost-saving properties of MBIs in the findings of this study, more interventions and research are needed to document the extent to which MBIs could be successfully implemented in communities or regions with lower economic resources. Indeed, given the encouraging findings related to the cost-effectiveness and cost savings of the studies reviewed, low-resource settings might need these MBIs more than high-resource countries. In addition to health and cost-effectiveness benefits, concerns regarding participant recruitment, retention, and adoption, all of which are impacted by social determinants that may result in

| Author, year, country | Study population | Study design/blinding procedures | Comparator | Mindfulness intervention | Comparator | Health economic cost per couple | Perspective/time horizon | Results |
|-----------------------|------------------|-----------------------------------|------------|--------------------------|------------|--------------------------------|--------------------------|---------|
| Steegers-Theunissen et al., 2020, Netherlands | Couples with fertility issues and obese women undergoing reproductive technology treatment (in the context of the Netherlands) | Simulation model | Mindfulness intervention | Mindfulness intervention | Health economic cost per couple | Healthcare/annual costs per pregnancy (up to 6 weeks post partum) | Direct medical costs related to the intervention, fertility treatment, and pregnancy (up to 6 weeks post partum) | Mindfulness interventions resulted in reduction in number of in vitro fertilization (IVF) treatments by 11.8% and intra-cytoplasmic sperm injection (ICSI) by 0.9%. The cost saving for mindfulness intervention was €36 (USD44) per couple per year |

Abbreviations: EUC, enhanced usual care; MBCT, mindfulness-based cognitive behavior therapy; MBSR, mindfulness-based stress reduction; MBPBS, mindfulness-based positive behavior support; PBS, positive behavior support; QALY, quality-adjusted life years; RCT, randomized controlled trial; SA, sensitivity analysis; UC, usual care

Monetary values with a specific year were converted to 2020 US dollars and put as USD.
disparity, should also be assessed when considering implementation, sustainability, and feasibility.

Due to the variations in the types of MBIs, populations included, health outcomes targeted, differences in study designs, and time frames for assessing outcomes, it was not possible to conduct a quantitative meta-analysis of the cost saving or cost-effectiveness of MBIs. Efforts to report data that could be more easily statistically compared would assist such efforts in the future. More studies could also be done to understand better the overall cost savings of MBIs from the societal perspective, as most of the articles reviewed in this study still were limited to the healthcare perspective of cost savings.

MBSR has been shown effective in reducing symptoms of anxiety and depression, perceived stress, blood pressure, and body mass index among patients with coronary heart disease (Parswani et al., 2013). Strong and consistent evidence indicates that MBIs can lower blood pressure

| Author, year | Drummond’s checklist items # |
|--------------|-----------------------------|
|              | 1 2 3 4 5 6 7 8 9 10        |
| CEA Saha et al., 2020 | ✓ X ✓ ✓ 0 ✓ NA ✓ ✓ ✓ |
| Bogosian et al., 2015 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ X |
| van Dongen et al., 2016 | ✓ ✓ ✓ 0 ✓ ✓ NA ✓ ✓ ✓ |
| Herman et al., 2017 | ✓ ✓ 0 ✓ ✓ 0 NA ✓ 0 X |
| Johannsen et al., 2017 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ X |
| Kuyken et al., 2008 | ✓ ✓ ✓ ✓ ✓ ✓ X ✓ 0 ✓ |
| Kuyken et al., 2015 | ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| Lengacher et al., 2015 | ✓ ✓ ✓ X ✓ ✓ ✓ ✓ ✓ X |
| Prioli et al., 2017 | ✓ X ✓ ✓ 0 NA ✓ 0 ✓ |
| Shawyer et al., 2016 | ✓ ✓ ✓ ✓ ✓ ✓ 0 NA ✓ ✓ ✓ |
| van Ravesteijn et al., 2013, van Ravesteijn, 2016 | ✓ ✓ ✓ ✓ 0 0 NA ✓ 0 ✓ |
| Pahlevan et al., 2020 | ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| Compen et al., 2020 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ ✓ |
| Müller et al., 2019 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ ✓ |
| Janssen et al., 2019 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ ✓ |
| Pérez-Aranda et al., 2019 | ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ NA |
| Herman et al., 2020 | ✓ ✓ ✓ ✓ ✓ ✓ 0 NA X ✓ |
| Bogosian et al., 2021 | ✓ ✓ ✓ ✓ ✓ ✓ 0 ✓ ✓ ✓ |
| CBA Fjorback et al., 2013 | ✓ ✓ NA ✓ 0 ✓ 0 NA ✓ ✓ |
| Klatt et al., 2016 | ✓ ✓ NA X ✓ ✓ X NA ✓ X |
| Knight et al., 2015 | ✓ X NA X ✓ ✓ X NA ✓ ✓ |
| Rakel et al., 2013 | ✓ ✓ NA X ✓ ✓ NA NA ✓ ✓ |
| Singh et al., 2008 | X X NA X X X X X X X |
| Singh et al., 2015 | X X NA ✓ ✓ X NA X X |
| Singh et al., 2016a | X X NA ✓ ✓ X NA X X |
| Singh et al., 2016b | 0 ✓ NA ✓ ✓ X NA X X |
| Singh et al., 2020 | ✓ ✓ NA ✓ ✓ ✓ NA X ✓ |
| Steegers-Theunissen et al., 2020 | ✓ ✓ NA ✓ NA ✓ NA X ✓ |

✓ = criteria satisfied; X = criteria not satisfied; NA = not applicable; 0 = unclear

This table is computed based upon the 10-item Drummond’s checklist: 1. Was a well-defined question posed in answerable form? 2. Was a comprehensive description of the competing alternatives given (i.e., can you tell who did what to whom, where and how often)? 3. Was the effectiveness of the programme or services established? 4. Were all the important and relevant costs and consequences for each alternative identified? 5. Were costs and consequences measured accurately in appropriate physical units (e.g., hours of nursing time, number of physician visits, lost work-days, gained life years)? 6. Were the cost and consequences valued credibly? 7. Were costs and consequences adjusted for differential timing? 8. Was an incremental analysis of costs and consequences of alternatives performed? 9. Was allowance made for uncertainty in the estimates of costs and consequences? 10. Did the presentation and discussion of study results include all issues of concern to users?
(Parswani et al., 2013; Shi et al., 2017), and MBSR generally shows promise in addressing symptoms for people with hypertension (Conversano et al., 2021). MBIs have growing support as a promising treatment for obesity-related eating behaviors as well (O’Reilly et al., 2014). Cost-effectiveness or cost analyses on MBIs for people with cardiovascular conditions would be informative. In addition, arthritis ranks among the top five chronic diseases which contribute the most to national healthcare expenditures (Lee et al., 2017). Economic evaluations of MBIs with demonstrated effects among arthritis patients could also be worthwhile.

Similarly, with the ongoing and growing healthcare impacts resulting from opioid addiction and other substance misuse disorders (Haigh et al., 2018), MBIs for those in recovery for substance misuse disorders, such as MBRP, have been developed and standardized to become a notable option to control addictive behaviors (Garland, 2016; Grant et al., 2017; Li et al., 2017). However, economic evaluations of MBIs targeting substance misuse/relapse prevention have not been conducted. Given the substantial healthcare burden of drug and alcohol misuse disorders (Barrio et al., 2017; Inocencio et al., 2013) and MBIs’ emerging role in reducing substance abuse, future research needs to address these research gaps with rigorous study designs.

Additional research could also be done to further the understanding of the potential role of MBIs beyond the individual level. MBIs have been associated with increased labor productivity (Bhargava et al., 2001), reduced tax burden (Bhargava et al., 2001), and reductions in care facility employee turnover and disability insurance (Singh et al., 2008, 2015, 2016a, b, 2020), which provide evidence that MBIs could create cost savings for society at large. More research regarding MBIs and productivity can in turn inform discussions on issues such as private sector human resources development (Dewa & McDaid, 2011) as well as public sector investment in the future labor force.

In summary, while MBIs are not yet commonly covered by health insurance, this review study synthesized evidence for decision-making about whether MBIs should be covered by health insurance. More economic evaluations of MBIs in areas such as physical health and substance use will broaden the understanding about their cost-effectiveness and cost-saving properties for both healthcare and society.

Author Contribution LZ contributed to the conceptualization of the study and led the methodology development. SL contributed to the methodology. LZ and SL conducted the literature search and analysis of articles, and collaborated on the writing of the manuscript and revisions. TL contributed to the methodology of the study. KOJ contributed to the article coding and manuscript writing. TL, KOJ, LC, MJ, and HZ reviewed and edited the manuscript. LS conceptualized the study and collaborated on the development of the methodology, writing of the manuscript, review, and revisions. Lingling Zhang and Snehal Lopes are the co-first authors.

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Declarations

Conflict of Interest The authors declare no competing interests.

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