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OBM Integrative and Complementary Medicine

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Review

The Cost-Effectiveness of Mindfulness-Based Interventions for Medical Students: A Scoping Review

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Academic Editor: Marianna Mazza

Collection: Mind-Body Approaches that are Revolutionizing the Health Field

OBM Integrative and Complementary Medicine
2025, volume 10, issue 1
doi:10.21926/obm.icm.2501007

Received: August 16, 2024
Accepted: January 01, 2025
Published: January 23, 2025

Abstract

This scoping review aims to understand the available research and the quality of evidence about the cost-effectiveness of mindfulness-based interventions when applied to the medical student context. There is considerable literature pertaining to the application of mindfulness-based interventions in this context. However, the links between cost and effectiveness need to be established to ensure the relative integrity of these therapeutic systems. The participants included in the study were medical students (undergraduate and postgraduate). The concept under inspection concentrated on mindfulness-based interventions' cost-effectiveness, and the context was defined within the medical education setting—exclusion criteria required focusing on empirical studies published in peer-reviewed English language journals. Initially, a search protocol using the SPIDER system (Sample, Phenomenon of Interest, Design, Evaluation, Research type) was employed, followed by the development of a search algorithm. The literature search employed seven online databases, and the quality of evidence revealed within the final articles was analyzed. A summary table was developed classifying

the first author, year of study, research design, cost and effectiveness. More specifically, the cost was evaluated in terms of financial outlay, acquisition of resources, and time involvement. In addition, effectiveness was determined by the impact of the intervention on students' well-being and learning. A final review of 12 English language articles was conducted. The various costs identified included financial outlay on specialist personnel, venue provision, acquisition of measurement instruments, and time spent on the intervention. In reference to effectiveness, the evidence from the randomized or nonrandomized control studies indicated reduced perceived stress scores, reduced anxiety, alleviation of depression, and improved psychological health with some indication of improved learning management skills. Two nonrandomized cohort studies reported positive changes in levels of exam-induced salivary cortisol concentration. This scoping review revealed that no studies had comprehensively linked the costs of the intervention with purported levels of effectiveness. Future research needs to itemize the costs of the intervention and explicitly assess their links to effectiveness, such as well-being and learning.

Keywords
Mindfulness-based Intervention; cost-effectiveness; medical students; scoping review

1. Introduction

There is considerable literature pertaining to the application of mindfulness-based interventions (MBIs) in higher education [1, 2]. The descriptions of MBIs vary across contexts and according to philosophical belief systems. *Mindfulness* has become a popularized entity with the advent of evidence that supports its integration into strategies and treatments, such as mindfulness-based stress reduction (MBSR) [3] and mindfulness-based cognitive therapy (MBCT) [4]. Incorporation of the word mindfulness implies that MBIs are therapies that engender qualities of non-judgment, awareness, acceptance, and compassion [5]. Formal practice often entails incorporating practices such as sitting meditation, attending to the breath, mindful walking and evoking a body scan [5].

The practice of mindfulness has often been considered alongside positive thinking, given that mindfulness differentially impacts thoughts highlighting negativity or positivity [6]. In addition, the practice of positive thinking that involves cultivating thoughts that emphasize positivity, is often linked to well-being outcomes [6]. In this study, we have embarked on an area of research exploration by considering the cost of MBIs (time, effort, and money) and how this cost translates to effectiveness in terms of evoking positive health and learning change in students studying in the medical education context. The linking of cost with effectiveness is a novel idea and is essential to the integrity of the intervention and its relative value.

The efficacy of MBIs has been well-researched, especially within the higher education context [1, 2]. For example, Fagioli and coworkers [1] examined how a brief MBI adapted for the online learning environment during the advent of the COVID-19 pandemic could positively influence self-awareness, academic self-efficacy and a sense of belonging. In the post-intervention phase, they found that students in the intervention group reported higher total scores on academic self-efficacy, a significant increase in community engagement, improved attention regulation, and reduced

psychological distress. The flaws of this research are aligned with risks of bias in the evidence being presented, for example, the problem associated with implementing an effective blinding protocol. In addition, this study was unable to demonstrate a sustained beneficial effect, given the utilization of a cross-sectional study design.

Moreover, considerable research has been conducted in relation to the medical student context [7-9]. In their recent systematic review, Kaisti and coworkers [7] created a detailed summary of the quantitative and qualitative results of studies that investigated the utility of MBIs in the medical education context. With reference to the controlled and uncontrolled individual studies, beneficial effects were noted following involvement in the MBI. These were in areas of increased mindfulness, reduced adverse stress, decreased mental distress, and a higher degree of well-being and self-compassion. The studies were limited by small sample sizes ($n < 10$), a lack of a control group, and only a small number of studies were able to be quantitatively analyzable. In a further systematic review, Hathaisaard and coworkers [8] suggested that MBIs have likely benefits in reducing the experience of adverse stress on medical students. They reported that the overall risk of bias in the reviewed studies was high, mainly due to problems associated with blinding interventions or outcome assessments, alongside high levels of missing outcome data.

In this scoping review, our intent was to extend the analysis of these previous reviews by considering the impact of cost. Traditionally, several economic measures have been cited in the clinical context, which include cost per life year saved, cost per case cured, and cost per symptom-free day [10]. We aimed to explore the evidence associated with cost more generically in terms of time, money and resources and how these were linked to optimizing the efficacy of MBIs. More specifically, we aimed to assess the cost-effectiveness of MBIs as it relates to the medical student population. In our preliminary search of the literature on the general cost of MBIs [11], we theorized that little is known about the costs associated with the demonstrated health or learning benefits. In addition, by reviewing the notion of cost we aimed to comment on the effectiveness of MBIs in relation to other potentially beneficial therapeutic modalities, such as forest bathing [12]. The scoping review aimed to critically evaluate the evidence on the cost-effectiveness of MBIs, focusing on their efficacy in improving well-being and learning outcomes among medical students.

2. Materials and Methods

2.1 Search Process

Using the JBI website we rationalized the application of a scoping review [13]. Scoping reviews provide a systematic evidence synthesis approach for evaluating evidence and determining gaps in the literature across a variety of fields [13]. In the area of cost-effectiveness and its relation to the medical education context, we wanted to assess all published articles alongside consideration of the quality of the study methods employed. Other review methods were considered [14]; however, other methods tend to utilize either systematic reviews, meta-analyses, or narrative reviews, which would not serve the purpose of this review. This review focused on scoping the literature instead of testing an effect or providing a descriptive analysis of the findings.

After deciding on the type of review approach, we developed a search strategy. In this review, we used the SPIDER strategy (sample, phenomenon of interest, design, evaluation, research type), as it is specifically designed to locate studies using various research paradigms, such as quantitative, qualitative and mixed-method studies [15]. The SPIDER system, thus, allows for a more inclusive

search of quantitative and qualitative empirical research and is sensitive to locating key articles. This search strategy is particularly suited to assisting with the implementation of scoping reviews. Moreover, the SPIDER system was used because the phenomenon of interest could be linked to the notion of MBI, both quantitatively and qualitatively. We were also interested in collecting information from various research designs, and emphasized evaluative research. As such, we preferred the term 'evaluation' rather than 'outcomes' [16].

The outcomes of the SPIDER process were used to create the generic search algorithm. Several trial algorithms were explored in terms of breadth of study capture, and librarian expertise was sought to fine-tune the search strategy, after which a final algorithm was developed. The final keyword search strategy is presented in Table 1. The subsequent final detailed search algorithm derived from the use of the SPIDER system to search all databases was: *(medic* AND students) AND (mindful* OR meditat*) AND (health OR wellbeing OR "quality of life" OR "academic performance" OR achievement OR effect*) AND (time OR resources OR money OR financ* OR effort OR cost)*.

Table 1 SPIDER search strategy: Keywords and word search strategy used in the database searches.

Sample	Medic* AND students
Phenomenon of Interest	Mindful*, mindfulness-based intervention OR mindful-based cognitive therapy OR meditat*
Design	All designs
Evaluation	Quality of life OR well* OR being* OR health OR academic performance OR time OR resources OR effort OR cost* OR effective* OR money OR financ*
Research Type	Any

2.2 Study Selection

The following steps outline the study selection process and the inclusion/exclusion criteria:

1. Full-text studies were included with medical students (undergraduate or postgraduate) as the sample and mindfulness-based interventions (MBIs) as the phenomenon of interest or intervention.
2. Peer reviewed studies published in the English language were included. Studies published in other languages were excluded due to resource limits.
3. Both qualitative and quantitative studies were included. The following types of publications were excluded, given they were unlikely to be rigorously peer-reviewed: grey literature, books, book chapters, newspaper articles, and magazine articles. Research theses could be included.
4. Duplicate studies were removed.
5. Two authors (DL and MH) independently reviewed article titles and abstracts. Studies were selected for full-text assessment based on consensus between four authors (DL, MH, LN, and YC).
6. Two authors (DL and MH) independently retrieved and reviewed the full texts of selected studies. The inclusion of articles in the evidence synthesis was based on a consensus between four authors (DL, MH, LN, and YC). Disagreements were discussed among the research team until a complete consensus was reached. No statistical methods using inter-rater coding were

implemented, given that decisions for inclusion and exclusions were discussed in an open, qualitative, informed and collegial manner.

7. Hand-searched articles were evaluated and nominated following the same selection process.
8. Studies that focused on medically trained residents and postgraduate specialty trainees were excluded.
9. As shown in the search algorithm, cost and effectiveness elements were required.

2.3 Search Protocol

On December 4, 2023, the literature search was conducted employing seven online databases (Medline, CINAHL, Embase, Scopus, PsycINFO, Cochrane, and Google Scholar) using the aforementioned algorithm (Table 1). Due to the expansive nature of Google Scholar compared to the other databases, only the first 100 articles were considered, given that this number was similar to the total number of results from different databases.

The detailed scoping review approach involved consulting with a specialist librarian, developing a search strategy, designing a search algorithm, sifting through the vast array of papers, eliminating and retaining papers by title and abstract, and reading the full text. Deciding on the final papers required numerous meetings with co-authors to ensure accuracy and consensus. The final review enabled the development of a summary table (Table S1, which was created as a supplementary table).

2.4 Data Analysis

References were stored in the reference management software EndNote 21 [17]. Search results were imported into a Zotero reference manager, allowing for duplicates to be removed. The papers were then manually screened, using the Zotero reference manager, to determine the full-text articles. More specifically, DL retrieved and read full-text articles for eligibility screening and discussed them with YC, MH, and LN. Papers were excluded according to the criteria stated above. The remaining articles were independently read in full text and screened by DL, MH, LN, and YC for eligibility and removed for the above reasons or if the costs or outcomes were unclear or undefined. Ambiguity and clarity were discerned from carefully deciphering the results provided in the papers and the actual authors of the papers were not consulted.

A PRISMA flow diagram was used to help identify the relevant articles (Figure 1). Disagreements were resolved collegially at regular weekly verbal meetings, and the key frame of reference was aligned with the inclusion and exclusion criteria. As stated above, any variations were discussed at length at the online meetings. Papers were only included after complete consensus was determined.

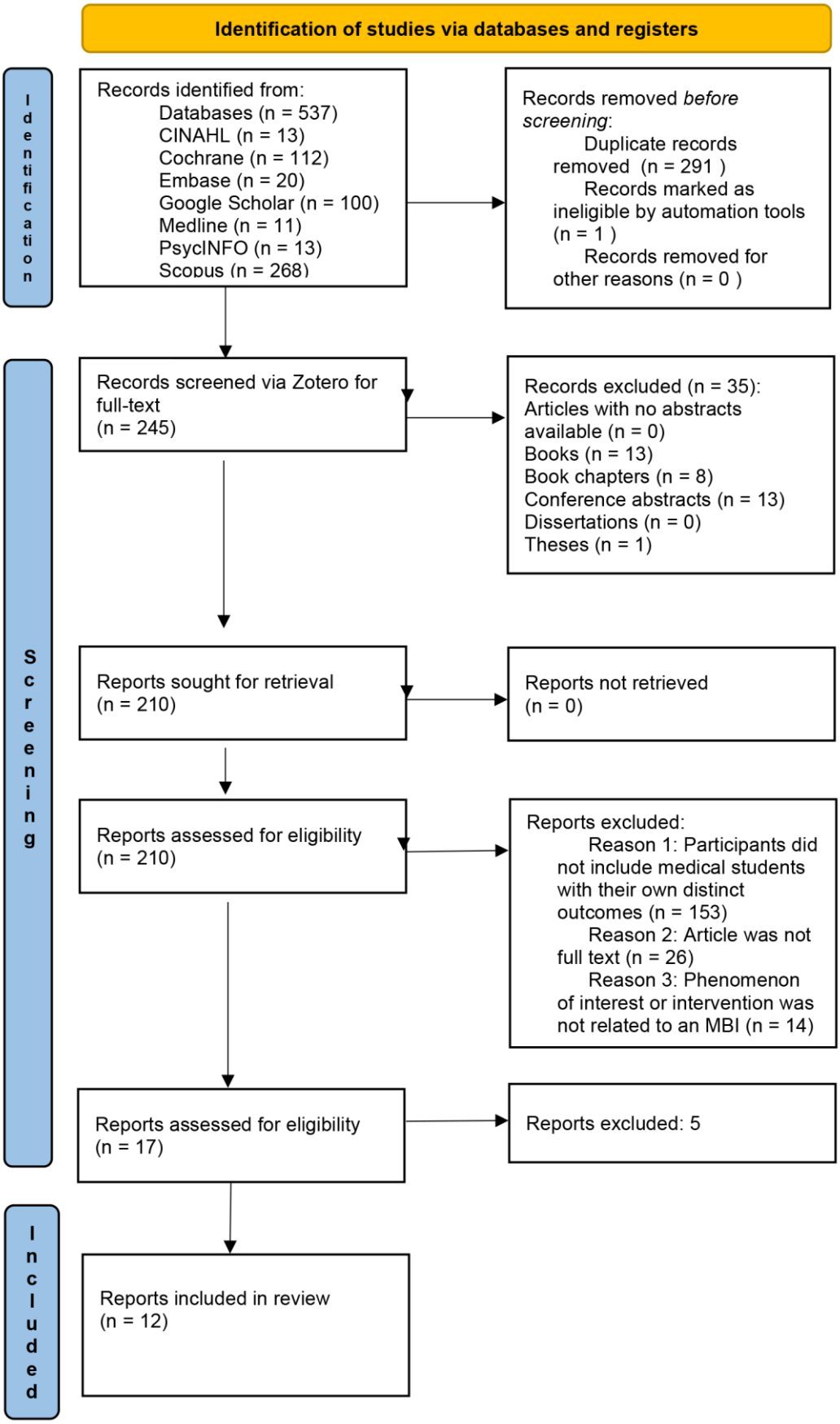

Figure 1 PRISMA diagram.

The quality of the evidence was analyzed using two procedures. First, the Cochrane risk of bias criteria for randomized or nonrandomized control studies were employed (Table 2) [18-21]. Second, the Newcastle-Ottawa Scale assessed the evidence quality of nonrandomized cohort studies (Table 3) [22]. A table summary of articles was developed, and this was classified by the first author, year of study, research design, cost, and claims of effectiveness (Table S1).

Table 2 Applying the Cochrane Risk of Bias criteria by levels of evidence for reviewed randomized or nonrandomized control studies (n = 4).

Article	Randomization	Allocation concealment	Blinding	Attrition bias	Reporting bias	Other bias
Erogul et al. [23]	Low risk	Unclear	High risk	Low risk	Low risk	Unclear
Shapiro et al. [24]	Low risk	Unclear	High risk	Unclear	Low risk	Unclear
Wang et al. [25]	Unclear	Unclear	High risk	Unclear	Unclear	Unclear
Rosenzweig et al. [26]	High risk	Unclear	High risk	Unclear	Moderate risk	Unclear

Table 3 Applying the Newcastle-Ottawa Scale (NOS) for assessing the quality of reviewed nonrandomized cohort studies (n = 8).

Article	Selection	Comparability	Outcome
Abrams et al. [27]	***		**
Hearn and Stocker [28]	***		**
Kaur et al. [29]	***		**
Pham et al. [30]	***		**
Prasad et al. [31]	***		**
Rashid et al. [32]	***		**
Ross et al. [33]	***		***
Thompson et al. [34]	***		**

Note: Asterisk allocation was conducted according to NOS coding criteria [35].

2.5 Ethics Statement

This is a scoping review and therefore did not require institutional ethical approval.

3. Findings

The initial search yielded 245 articles. After screening with the Zotero reference manager, this number was reduced to 210. The articles were retrieved from their databases, and their full texts (where available) were screened. From this analysis, 193 articles were excluded. All authors excluded five articles after full-text analysis, leaving 12 articles for the final review (see Figure 1 and Table S1). The reason for excluding these five papers was that, upon further review and discussion

among the authors, it was determined that these papers did not explicitly employ the MBI but rather a similar technique, such as CBT (cognitive behavioral therapy), or they did not measure a well-defined wellbeing or learning parameter, such as using cardiorespiratory fitness as a response outcome.

3.1 Quality of Evidence

In this review, there were three randomized control studies [23-25], one nonrandomized control study [26], and eight nonrandomized cohort studies [25, 27-34] (Table 2 and Table 3).

3.2 Cost of MBI

The various costs associated with the MBI are detailed in Table S1. Costs presented in the articles included: (1) engaging a registered psychologist [27], employing a certified Yoga practitioner [31, 34] or art therapist [25]; (2) providing a detailed time commitment [23-34]; (3) providing venue details [23]; (4) acquiring and using measurement instruments [23-34]; (5) detailing provision of resources, e.g., handouts [23]; and (6) presenting monetary incentives to participants [23]. No details were noted regarding the level of financial cost or use of digital programs/apps.

3.3 Impact on Wellbeing and Learning

In reference to effectiveness, the articles tended to provide evidence on the impact on well-being or learning. When evaluating the evidence emerging from the evidence shown in the reviewed randomized or nonrandomized control studies (Table 2), Erogul and colleagues [23] reported that medical students who had taken the MBI course were more likely to have reduced perceived stress scores than controls in the immediate post-intervention assessment. However, they could not show a sustained effect given that no difference was demonstrated 6 months after the study. Similar findings were indicated in the Wang and colleagues study [25], although they were able to demonstrate a 2-week sustained impact. Other psychological benefits were shown such as reduced anxiety, alleviation of depression, and improved psychological health [24, 26]. One nonrandomized cohort study suggested a sustained effect on the amelioration of adverse stress [31], while similar studies indicated improvements in self-compassion, empathy and learning management skills [27, 32, 33]. Furthermore, two nonrandomized cohort studies reported favorable improvements by reporting physiological measures (e.g., positive changes in levels of exam-induced salivary cortisol concentration) [28, 29].

4. Discussion

This study assessed the emerging evidence on the cost-effectiveness of MBIs in the medical student context. We determined the evidence in the articles that supplied elements of both cost and effectiveness regarding the impact of their MBIs on well-being and learning.

4.1 Evidence of MBIs and Its Impact on Wellbeing and Learning

This scoping review affirmed other reviews in the area [7, 8] by clearly indicating beneficial results when medical students engage in MBIs. In Table 2, we reviewed a set of randomized control papers

that affirm this claim. For example, Erogul and coworkers [23] undertook a randomized control study and provided thorough research design details (Table 2). It was clear that the treatment groups reported significantly higher self-compassion scores at the end of the study and at follow-up. Immediate improvements were noted in the treatment group when reporting perceived stress levels. However, these reported levels started to return to baseline after 6 months, suggesting that continued application of the MBI is required to maintain its initial effect. Integrating mindfulness or mindful practices as part of students' daily routines was not achieved, thus making them more likely to be reliant on delivery from an external agency. Further research could explore whether the principles and practice are internalized as opposed to whether external agents are consistently required to monitor progress. It was further noted that there were strong positive correlations between resilience and self-compassion scores for the treatment group, and this relationship was negative for the control group, suggesting that the levels in the treatment group were intertwined with self-compassion. However, it was noted that resilience scores were not significantly higher in the treatment group. Therefore, this study conducted on medical students concluded that an 8-week MBSR programme was able to demonstrably elevate self-compassion and reduce perceived stress.

In an example of a reviewed nonrandomized cohort study, Hearn and Stocker [28] investigated the potential of mindfulness meditation in reducing examination stress and subsequent performance. They measured the effect of the intervention by assessing perceived stress (asking students to rate their level of stress), gauging students' salivary cortisol, and asking students to rate elements of mindfulness (using the five-facet mindfulness questionnaire-short form, FFMQ). This study showed that exam conditions adversely raised cortisol levels, and increased cortisol levels were correlated with diminished exam performance. Regression analysis indicated that elevated FFMQ scores were associated with reduced levels of exam-induced salivary cortisol levels and increased examination scores. However, the measures of perceived stress used in the study were not related to changes in reported mindfulness scores. Other nonrandomized cohort studies, such as Prasad and coworkers [31], found that a Yoga-based intervention had a positive impact on reducing perceived levels of adverse stress. The effect of the interventions in both of these studies was conducted without the presence of a comparative group. Hence, the risk of bias was likely high [36]. Nonetheless, with yoga and other interventions mentioned, the emphasis was on group-based rather than individual effects. Therefore, more research is required to appraise whether a group-based delivery could be perceived as a *cheaper* and more effective option when compared to individual coaching. Furthermore, it is important to acknowledge that marked effectiveness may be more noticeable when investigating case-by-case involvement at an individual level. An additional cost-effectiveness consideration includes the delivery of interventions in-person versus online, especially given the rise of software development and the use of electronic devices [11].

4.2 The Evidence on the Cost of Implementing MBIs to Promote Wellbeing and Learning

The various costs associated with the MBI are detailed in Table S1. Before the commencement of the study, we envisaged that we could categorize costs by time, financial payment, and resources, culminating in an estimate of cost-effectiveness. After completing this scoping review, it was clear that all the reviewed MBI articles did not detail a financial cost or budget per se, although time was loosely presented, which could provide a proxy estimate for labor cost [37]. However,

comprehensive details on labor costs were not evident, thus making a detailed evaluation of the cost of time unclear. Nevertheless, it could be discerned that the time cost varied across studies (Table S1) from brief interventions [29] involving only 8 to 10 minutes a day for four weeks to very complex interventions requiring 75 minutes once per week for 8 weeks [23]. Given details were limited, it was not possible to definitively ascertain the impact of dose (investment of time) on effect [38].

Some studies indicated employing a registered health professional for group sessions [25, 27, 31, 34], although financial details were not forthcoming. Other costs involved administering questionnaires [25, 27, 31, 34] and the use of a handout [22]. It is likely that the venues would be at the institution where the study was conducted, and only one study provided full venue details [22]. One study [23] also emphasized provision of a financial incentive, which may have biased the results [39]. Therefore, given the disparate range of details it was not possible to compute a conclusive cost-effectiveness analysis. A more targeted approach to discerning cost-effectiveness is required to establish MBIs as a cost-effective intervention. For example, studies conducted in other areas could guide future research in this field, such as the research being conducted to ascertain the cost utility of a psychological intervention aimed at ameliorating depression in primary care [40].

Nonetheless, the research context of these studies implied that it is not possible to discern whether more elaborate interventions yield better results than adjudged less elaborate interventions. It is additionally not possible to accurately assess whether engaging a professional resulted in more positive outcomes. However, based on this scoping review we are able to discern that the two major costs for research-based studies evaluating the efficacy of the MBI are likely to be time costs and procurement of valid measurements.

A major implication of this scoping review relates to the generalizability of findings, given we were unable to ascertain if MBIs outside of university settings had a greater or lesser effect than those within university settings. It is likely that the students in these reviewed studies did not pay a fee and, in one case, received an incentive. Thus, the findings cannot be generalized to people (students or otherwise) engaging in courses requiring a set fee outside of university settings. This poses a further question - would MBIs be more effective if students were required to pay for engagement compared to the current protocols? Payment for participation would likely mirror the more commercial side of MBIs being offered to the broader community [11], which is pertinent for medical students given that they are likely to be exposed to commercial MBIs both during and after they have finished their medical training. These are clearly questions to be unraveled in further research.

4.3 Quality of Evidence

The overall assessment of the studies in this scoping review is that the evidence quality of the reviewed studies is questionable. Starting with the studies with the highest level of evidence (Table 2), we note that all studies [23-26] reviewed had problems associated with allocation concealment, blinding, reporting bias and three of the studies [24-26] indicated attrition bias. This finding is not unique, given that most reviews based on systematic search protocols cite similar problems [8, 41]. In these types of studies, it must be conceded that attrition, blinding, and allocation concealment are difficult facets to eliminate. It will be to participants and researchers who have engaged in informed consent, to realize if they are providing, receiving, or have received the MBI or not. This

could be avoided if the comparative group was given a therapeutic intervention that has an aspect of mindfulness but omits key facets of the full MBI. In addition, the personnel involved in allocating the groups would need to be blinded to the group allocation. This most likely would work if the two venues were in different geographical regions and the control group venue is remote from the experimental group location. To avoid further contamination of adding confounding elements, the sites must be very similar in all other aspects. Furthermore, in an ethical study, participants are allowed to leave the study at any time. In these types of studies that often occur over a defined period of time, participants will likely miss or stop attending sessions.

A further major flaw in the studies reviewed is the problem of conducting studies with no control group or no comparison therapy group. Therefore, other approaches to alleviating stress amongst medical students may have the same impact as MBIs; however clearly, more work is required to verify this claim. Given the lack of information around cost, we cannot compare MBIs with other potentially efficacious therapies, such as forest bathing [12], which generates other costs, such as transportation to a forested region and the potential use of a guide or facilitator. Nevertheless, Hansen and coworkers [12], in their research into the impact of forest bathing, also acknowledge that research into the benefits of this therapeutic process has limitations such as most studies reported on the experiences of predominantly healthy, young, male university students. As with much research in this area there is difficulty fully explaining the effect of the multi-layered environment. Nonetheless, comparative research between formulaic MBIs and naturalistic, low-cost activities will likely be worthwhile.

In addition, it could be argued that an untainted randomized controlled trial may not be possible in such research, and other research methods need to be considered, such as multiple baseline research paradigms. Similar to randomized controlled trials, the multiple baseline design can show changes in behaviors and that these changes are a product of the intervention [42]. The advantage of this design is that demonstrated changes can be shown using small groups, and the comparative elements are inherent within the design [42]. Therefore, issues of attrition and concealment are likely no longer problematic.

5. Conclusions

This scoping review clearly demonstrates that more studies are required to establish the links between costs and effectiveness. In this scoping review, we found no studies that had comprehensively explored this association in the context of medical education. Given that some of the references provided findings indicating low levels of evidence, cautionary elements associated with research design and optimization, and some articles were deemed outdated, future studies need to apply higher-quality research protocols, such as employing multiple baseline design methodologies. Therefore, it is clear more work is required in this area alongside further improvements in study designs measuring the health impact of MBIs on medical students. This claim is likely valid for other university student groups. This is important given the number of commercially based MBIs [43] that are being developed and offered without evidence assuring that they may make a demonstrable difference compared to low-cost, naturalistic interventions.

6. Recommendations for Further Research

To develop a more detailed meaningful cost-effectiveness argument, future research requires:

1. More detailed budgetary elements.
2. More comparative studies that can compare MBIs with other more naturalistic therapies, such as walking, swimming and forest bathing.
3. Further evaluation of the cost-effectiveness and acceptability of MBIs across subcultures, for example, their applicability to ethnic, gender, and disability groups.
4. Work to be conducted on developing innovative, robust research methods and measurement protocols that have lower risks of bias, e.g., multiple baseline designs.
5. Additional studies employing a mixed methods focus, which can provide measures beyond self-report questionnaires to delve into the rich narrative underscoring the effectiveness of the intervention.
6. Studies demonstrating greater generalizability and providing a more pragmatic long-term value.
7. Future studies to include a comparative assessment of individual versus group MBI approaches.
8. Disentangling mindfulness as a way of life (or sense of being) versus a specified clinical intervention.

Author Contributions

Five authors (DL, MAH, LN, FS, and YC) contributed to the conception or design of the work analysis, and interpretation of data for the work. Four authors (DL, MAH, LN, and YC) were involved in the deliberation of the acquisition of the papers for review. All five authors engaged in the final write-up of the paper (editing, providing feedback and final approval). All authors contributed to revising the paper critically for important intellectual content. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding

This project was partially supported by the University of Auckland Summer Research Scholarship and advice on developing the search strategy was provided by the university librarian services.

Competing Interests

The authors have declared that no competing interests exist.

Additional Materials (if any)

The following additional materials are uploaded at the page of this paper.

1. Table S1: Summary of articles arranged in alphabetical order by first author.

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