

SYSTEMATIC REVIEW

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Consuming a healthy diet and engaging in physical activity (PA) are two key health-promoting behaviors [1, 2] that are associated with better mental health [3–5] and that may reduce the risk of non-communicable diseases, including heart disease, certain types of cancer, and type 2 diabetes [6, 7]. As promoting these behaviors remains a challenge, there is a need for efficient programs that encourage sustainable behavior changes. Increasingly, mindfulness-based strategies are used to encourage the adoption of such behaviors [8–11].

Mindfulness originates from traditional Eastern religious practice and has become a prominent approach in Western psychology to promote both health behaviors and mental health [12]. It is often represented as a multifaceted construct with underlying attentional and attitudinal processes [13–15]. Within the attentional component, an individual regulates the focus of their attention by bringing awareness to their present-moment environment and to their behaviors, thoughts, and feelings [13]. The attitudinal component describes the skill of responding to one's internal and external awareness with an orientation that is accepting, curious, and open [13].

Mindfulness can be cultivated through formal meditation training or through informal mindfulness exercises (i.e., those that are integrated into daily life) [16]. Formal mindfulness meditation training (e.g., body scan, sitting meditation, and mindful movement) is one key component of the standardized, clinical mindfulness-based training Mindfulness-Based Stress Reduction (MBSR) [17]. The standardized MBSR curriculum is composed of a standardized set of training sessions that teach formal exercises as well as informal mindfulness practice [18]. These standardized programs have demonstrated effectiveness in promoting various mental and behavioral health outcomes as well as quality of life in healthy adults [18–21].

Apart from standardized programs, there is a growing trend toward utilizing other, selected mindfulness-based strategies of varying durations and formats [22] to promote healthy dietary and PA behaviors. Such unstandardized mindfulness-based interventions (UMBI) can range from one-off, brief mindfulness inductions [23, 24] to several months of mindfulness practice [25], and may vary in their application of formal and informal training. Many of those interventions lack adherence to a standardized mindfulness protocol in which a specific set of training sessions and durations (using formal mindfulness exercises and practice) is described. Throughout this paper, we therefore refer to interventions with a mindfulness component, but that do not adhere to a standardized protocol such as MBSR, as UMBIs. As UMBIs may have merits, systematic overviews are warranted to study

how mindfulness-based strategies are integrated in these UMBIs and which strategies may have potential for effect.

Existing comprehensive reviews [8–10, 26] have provided insight into the combined effects of standardized and UMBIs for changing health behaviors (e.g., binge eating and emotional eating [10, 27] or enhancing PA [9]). However, caution is necessary when interpreting the effectiveness of mindfulness-based strategies across standardized and unstandardized treatment protocols, as this may lead to an overestimation of the benefits of mindfulness for changing health-promoting behaviors. It is crucial to conduct reviews specifically examining the distinct effects of unstandardized MBIs to determine whether and which MBI components can be used best to promote health behaviors. Moreover, there is a scarcity of systematic reviews examining the effectiveness of UMBIs for promoting health behaviors.
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PROSPERO (CRD42022377663) and additional data can be found on OSF (osf.io/3jv2f).

Eligibility criteria

Reports were included if they (i) were published in a peer-reviewed journal, (ii) applied a mindfulness-based strategy or intervention component (e.g., body-centered meditation or mindful observation) outside of a standardized mindfulness-based protocol (e.g., not following the full standardized MBSR or Mindfulness Based Cognitive therapy, MBCT, curriculum), (iii) targeted and separately reported on a healthy adult sample (i.e., non-treatment seeking individuals without physiological, neurodegenerative, or mental health conditions), (iv) were published in English, Dutch, or German, and (v) subjectively self-reported or objectively measured PA behavior or healthy dietary (sub-)behaviors (e.g., the consumption of fruits and vegetables, refraining from high-calorie snack intake, or compliance with dietary recommendations) at both pre- and post-test. Articles were included regardless of their employed measures of diet and PA outcomes (e.g., valid, reliable, and standardized questionnaires or non-validated single item-measures or indices) and regardless of their study design as long as a pre-test and post-test were included. Given the abundance of research on mindfulness and PA outcomes, we decided to conduct this portion of the review as an addition to Schneider et al. [9] (who combined unstandardized and standardized programs), and included suitable studies on PA published after June 2018 to avoid considerable over-

reported healthy dietary behavior, and 21 focused explicitly on physical activity outcomes. The study characteristics are described per targeted behavior(s) to gain insight into potential differences between programs with one versus multiple relevant behavioral outcomes.

Study characteristics

Studies focusing exclusively on healthy dietary behaviors ($n=7$) analyzed a total of 516 participants, with 268 in a mindfulness-based condition. Mostly young or middle-aged females made up the sample ($M\%female=90.4$ [$SD=15.8$]; *Age*

Table 1 Summary of intervention characteristics

	Healthy Eating		Physical Activity		Both Behaviors	
	<i>Bibliography No</i>	%	<i>Bibliography No</i>	%	<i>Bibliography No</i>	%
Intervention Group Size (Analyzed)						
< 10	-	0	[39]	5	-	0
10–24	[39]	14	[40–47]	38	[25, 48–52]	38
25–49	[53–57]	71	[58–62]	24	[63–67]	31
50–100	[68]	14	[69–73]	24	[74–76]	19
> 100	-	0	[77, 78]	10	[79, 80]	13
Study Design						
RCT/CCT	[53–57, 68]	86	[42, 44, 45, 58, 59, 61, 62, 69–73, 78, 81]	67	[25, 49, 52, 66,	

of 11.2 weeks [SD=6.6]. Most studies had sessions that lasted around 2 h.

The 21 studies targeting PA predominantly made use of formal mindfulness practice or a combination of formal and informal strategies (see Table 1). Most studies utilized body-centered meditation, mindful observation or meditation with movement (e.g., yoga) to promote mindfulness. Most programs incorporated BCT clusters (most commonly shaping knowledge and feedback/monitoring), with an average of 1.3 [SD=1.4] clusters (range=0–5). Programs lasted 6 weeks on average [SD=2.8]. Half of the interventions were administered in an individual setting with varying session lengths (from individually chosen app use time up to a total of 24 h of practice time). In addition to certified yoga and mindfulness teachers or a staff member delivering the intervention, more than half incorporated an audio file, videos, or an app.

The 16 combined studies predominantly targeted mindfulness in a group or combined setting, employing both formal and informal meditation practice. Most studies administered body-centered meditation or meditation with movement (see Table 1). Eleven of the 16 programs included a BCT (most commonly shaping knowledge), with an average of 1.9 BCT clusters ([SD=1.7]; range=0–5). On average, combined programs lasted 7.5 weeks [SD=6.2], with practice time varying from individually chosen in-app time up to 5 h of daily practice.

Results of individual studies

Health behaviors were categorized into subgroups based

Eleven of the 44 studies evaluated between-group differences in mindfulness at the post-test (25%). Mindfulness increased significantly relative to a control group at post-test in six (54%) of the eleven studies (see Table 2).

Common intervention components of effective studies

To better understand the potential effective ingredients of the UMBIs showing a significant improvement at the between-group level (see Table 2), we compared these eight studies regarding their key intervention components. The four studies demonstrating significant improvements on different dietary behaviors (i.e., eating a balanced diet, energy, fat, and sugar intake; [39, 49, 55, 68] administered interventions that typically (i) lasted longer than six weeks with 2-h long sessions, (ii) were employed in an individual setting, (iii) did not uti-

[17], our findings suggest an inconsistent and diverse application of these intervention components within the studied articles. The observed heterogeneity in intervention components across articles poses a challenge to the systematic evaluation of specific mindfulness training methods in health promotion. As the rationale and selection process for specific intervention components remain unclear, there is a need for future research to evaluate and provide justification for the inclusion of specific components in UMBIs.

This review also found that the UMBIs often contained additional active ingredients related to behavior change (i.e., intervention components designed to modify the causal processes that underlie behavior regulation; Michie et al. [36]). Although addressing relevant determinants through a combination of behavior change strategies is essential for the promotion of health behaviors, the integration of UMBIs and BCTs can obscure the effects of either approach. Improvements in behavioral outcomes cannot be attributed to mindfulness alone due to the presence of such secondary intervention components (i.e., strategies that may cloud the effects of mindfulness processes). To combat the influence of secondary

abstraction by two independent reviewers. Due to the vast amount of hits, it was not possible to verify all abstracts. We therefore limited this to the verification of 10% of excluded abstracts, and 20% for the update, as well as full-text verification. We cannot rule out that potentially relevant articles may have been wrongfully excluded because of this, but as that there was only one excluded record that needed discussion after the double verification of 1,670 excluded abstracts, we believe that the chance of having missed important records is minimal. Also, because of the experience of CEP with data abstraction, we believe that the risk of inaccuracy in data abstraction is low. Extracted information on study methods, intervention components, measurement, and effects was verified by a second reviewer during the risk of bias assessment. If any important information had been missed during data abstraction, it is likely that another risk of bias reviewer (NCB or KB) may have identified it. Additionally, CEP, AO, and DdR carefully reviewed the data included in the tables and ensured accuracy by monitoring the translation of data extraction documents into table format.

Implications

This review indicates a number of methodological limitations that may hinder drawing a strong conclusion on the effectiveness of UMBIs (i.e., without a standardized mindfulness framework or protocol) for promoting health behaviors. To enhance our understanding of the effectiveness of (U)MBIs in modifying healthy dietary and PA behaviors, it is crucial to carefully plan the content of such interventions. Interventions may benefit from adhering to standardized frameworks and treatment protocols as well as from incorporating established frameworks. Such guidelines can ensure the MBI is administered without secondary components that may cause changes in health behaviors in the absence of mindfulness. Further research would also benefit from explicit component or dismantling studies to shed light on what the active ingredients of (U)MBIs should be. Such studies could compare the effects of an isolated component (e.g., a certain meditation technique aiming to increase, e.g., non-evaluative/acceptance components), with a version of the intervention that excludes this component. Furthermore, considering the predominantly low study quality identified in this review, it is imperative to evaluate future interventions using robust and adequately powered between-group study designs, allowing for a rigorous assessment of their efficacy. In this regard, it is essential to measure changes in mindfulness throughout the intervention period to gain insight into the potential mechanisms underlying behavior change.

Conclusion

This review demonstrates limited evidence of the effective-

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