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Effectiveness and Moderators of Computer-Based Health Education in Adults: A Systematic Review of Meta-Analytic Studies

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Abstract- ***This systematic review of meta-analytic studies aims to evaluate the effectiveness of computer-based health education interventions targeting adult populations. In recent years, the use of digital platforms for health education has become more prevalent, particularly due to their accessibility, scalability, and convenience. However, the actual impact of these interventions on health knowledge, behavior change, and health outcomes remains under-explored. This review consolidates findings from several meta-analytic studies to identify the key determinants of successful computer-based health education programs for adults. The analysis focuses on various moderators that influence the effectiveness of these interventions, including the type of health behavior targeted, the delivery method, the population characteristics (e.g., age, gender, educational background), and the duration of the intervention. The results highlight that computer-based health education can be an effective tool in promoting health literacy and behavior changes in adults, especially when tailored to specific needs and supported by appropriate instructional design. However, certain factors, such as the complexity of the health topic, the level of interactivity, and the availability of support systems, play significant roles in determining the success of these interventions. This review provides insights into the strengths and limitations of computer-based health education and offers recommendations for future research and practical applications in health promotion.***

Keywords: Computer-Based Health Education, Meta-Analysis, Effectiveness, Health Behavior Change, Health Literacy, Intervention Duration, Delivery Method, Adult Population, Instructional Design, Health Outcomes

1. Introduction

Health education has long been a fundamental tool in promoting healthier behaviors among individuals. It encompasses a wide range of interventions designed to assist people in adopting healthier lifestyles, whether that involves quitting smoking, improving dietary habits, managing stress, or addressing other health-related challenges. Defined as a combination of learning experiences designed to help individuals voluntarily change their behavior to improve their physical or mental health, health education can take many forms (Green et al., 1981; WHO, 2013). Traditional methods of health education focus on face-to-face interactions, where educators provide information and skills to facilitate behavior change, such as helping individuals reduce stress or quit smoking. In the digital age, however, the internet has emerged as a powerful tool for health education. With its ability to educate, inform, and encourage significant changes in behavior, the internet has facilitated the rise of Computer-Based Health Education (CBHE) interventions, which deliver health education through digital platforms (Grohol, 2010). These interventions can be provided online, offline, or a combination of both, providing broad accessibility to individuals across different demographics.

Computer-Based Health Education (CBHE) interventions have garnered attention for their potential in enhancing health knowledge and influencing behavior change. The effectiveness of CBHE interventions has been explored through various studies, with some comparing these interventions to traditional health education methods. Meta-analyses and single studies have shown that CBHE interventions can be effective, especially when compared to non-active control groups (Andrews et al.,

2010; Spek et al., 2007; Kodama et al., 2012; Reed et al., 2011; Wieland et al., 2012). Typically, CBHE interventions have been evaluated for their immediate effects after the intervention, with limited attention given to their long-term impact on health behavior (Barak et al., 2008; Carey et al., 2009). However, few reviews have systematically examined CBHE interventions across diverse health education domains, such as smoking cessation, weight control, and mental health (Lustria et al., 2013; Portnoy et al., 2008; Webb et al., 2010). Most existing meta-analyses have focused on specific applications, such as smoking cessation or depression management, without analyzing a broader range of health education topics.

The primary aim of CBHE interventions is to influence participants' health behavior by improving their knowledge, attitudes, and skills. These interventions are often based on science-driven theories and models such as Social Cognitive Theory (SCT), the Theory of Planned Behavior (TPB), or the Transtheoretical Model (TTM). Despite their shared theoretical foundations, CBHE interventions differ in their design and delivery, utilizing various technological features that may enhance or hinder their effectiveness. A crucial aspect of CBHE interventions is their ability to address diverse health topics, making them a versatile tool for health promotion. However, several challenges persist, such as high dropout rates and the novelty of digital learning tools, which can hinder participant engagement and long-term adherence (Lustria et al., 2009; Morrison et al., 2012).

While significant progress has been made in understanding the effectiveness of CBHE interventions, there remains a need for further research to determine which specific features of these interventions are most successful and for which populations. Although there is evidence supporting the efficacy of CBHE in promoting health behavior change, there is limited consensus on the factors that moderate these effects. Understanding the moderators that influence the success of CBHE interventions—such as the type of health behavior targeted, participant characteristics (e.g., age, gender), and study design—can help optimize the implementation and design of future programs.

Theoretical Background

In the context of prevention and health promotion, moderators are variables that influence the strength or direction of the relationship between an intervention and its outcomes. According to Baron and Kenny (1986), moderators can be either qualitative or quantitative and can affect how an intervention achieves its intended results. In the literature on CBHE, three primary clusters of moderators are commonly identified: intervention features, participant characteristics, and study design features (Lustria et al., 2013; Davies et al., 2012). These moderators are critical to understanding why some CBHE interventions are more effective than others, and they are typically assessed through effect sizes, which indicate the magnitude of the relationship between the independent and dependent variables.

Intervention Features

Intervention features, such as the use of established theories (e.g., SCT, TPB) and behavior change techniques, are key to the success of CBHE programs. Studies have shown that interventions that incorporate systematic theoretical frameworks, behavior change strategies, and additional communication methods—such as text messages—tend to achieve larger effects (Webb et al., 2010). However, the moderating effect of tailoring content to individual users remains inconclusive, with mixed results across meta-analyses (Lustria et al., 2013; Portnoy et al., 2008). Other factors, such as the level of user control (self-guided versus expert-guided) and the use of repeated assessments, have not shown consistent effects on the outcomes of CBHE interventions.

Participant Features

The characteristics of participants also play a role in determining the effectiveness of CBHE interventions. Some studies have suggested that younger participants and females are more likely to benefit from CBHE interventions (Portnoy et al., 2008). However, other studies have not confirmed

these findings (Lustria et al., 2013). Additionally, interventions targeting general populations have shown more success compared to those focusing on individuals with specific health conditions. Furthermore, interventions conducted within the United States have demonstrated larger effect sizes compared to those in non-US populations, possibly due to cultural and contextual factors that affect the receptiveness to digital health interventions.

Study Features

The design of the study itself is another important moderator of CBHE intervention effectiveness. Randomized controlled trials (RCTs) tend to yield larger effect sizes compared to quasi-experimental designs, as RCTs reduce the risk of bias and provide more robust data (Lustria et al., 2013). Therefore, future meta-analyses and studies that focus on CBHE interventions should prioritize RCTs to obtain more reliable and generalizable results.

Study Objective

The primary aim of this systematic review of meta-analyses is to evaluate the effectiveness of CBHE interventions for adults and to identify the moderators that influence these interventions' outcomes. Specifically, this review will compare the effectiveness of CBHE interventions with active traditional forms of health education and assess the long-term sustainability of their effects. By synthesizing data from multiple meta-analyses across various health education domains, this review seeks to provide a more comprehensive understanding of what makes CBHE interventions successful and how they can be optimized for different populations and health topics. The findings from this review will contribute to the development of more effective digital health education tools and inform future research directions in this area.

Method

Search Strategy

Two literature searches were conducted to identify relevant meta-analytic studies on computer-based health education (CBHE) interventions for adults. The first search was performed using academic databases, including ERIC, PiCarta, PubMed, PsycArticles, PsycINFO, and Academic Search Premier. The search terms used were designed to capture studies related to CBHE and its effectiveness. The following terms were used in the first search:

- meta-analysis OR systematic review AND online course, online intervention, online therapy, online learning, internet course, internet intervention, internet therapy, internet learning, web-based course, web-based intervention, web-based therapy, web-based learning, computer-based course, computer-based intervention, computer-based therapy, computer-based learning, distance learning, e-health, and e-learning.

To ensure comprehensive coverage and avoid missing any meta-analytic studies, a second search was conducted using the complete electronic catalogue of Leiden University. This catalogue covers a broad field of research on education, health, and psychology. In this second search, the following terms were used:

- meta-analysis combined with internet OR web OR computer OR electronic, and paired with health OR education OR training OR course OR therapy OR learning.

Inclusion Criteria

To be included in the systematic review, meta-analyses had to meet the following criteria:

1. **Effectiveness**: The meta-analysis must have measured the effectiveness of CBHE interventions by calculating a mean effect size based on comparisons between the experimental and control

conditions. The experimental condition must involve CBHE, which includes online, offline, or blended interventions that utilize computers. Traditional health education interventions, which do not involve computers, were not included in this review.

2. **Publication Date**: Meta-analyses published between 2008 and July 1, 2014, were included. Given the rapid advancements in CBHE, this six-year timeframe was chosen to capture the most relevant and up-to-date studies.

3. **Language and Peer-Reviewed**: Only studies published in English and in peer-reviewed journals were included.

4. **Participant Demographics**: The meta-analyses included studies that focused on adult populations (18 years and older). Studies involving children, adolescents, or students (ages not specified) were excluded from this review.

5. **Health Outcomes**: The meta-analysis must have measured outcomes related to the modification of specific health status in participants, such as improvements in knowledge, behavior change, or health indicators.

Screening and Analysis Process

After removing duplicates, titles and abstracts of the identified studies were reviewed to exclude those that did not meet the inclusion criteria. Full-text versions of the remaining studies were then assessed for final inclusion.

To analyze the included meta-analyses, the researchers used a data collection form adapted from the Cochrane Study Handbook (Higgins & Deeks, 2011). A specific checklist for analyzing meta-analyses in reviews was not found in the literature, but key methodological factors such as effect sizes, confidence intervals, heterogeneity, study designs, and publication biases were examined. A box-score approach was used to track the key characteristics of each study.

Effect sizes were reported as standardized mean differences (Cohen's d and Hedges' g). A small effect was considered for values starting at 0.2, medium starting at 0.5, and large for values above 0.8 (Cohen, 1992). Heterogeneity, defined as the variation in results beyond what can be expected from chance, was assessed using I^2 values, where 0% indicated no heterogeneity, and higher percentages indicated greater variability between studies. Values of 25%, 50%, and 75% were considered low, moderate, and high heterogeneity, respectively (Higgins et al., 2003).

In addition, publication bias was assessed, as systematic reviews have indicated that studies showing beneficial effects are more likely to be published than those with null or negative results (Delgado-Rodrigues, 2006).

Moderator Analysis

The effectiveness of CBHE interventions was studied with a focus on three key categories of moderators: **intervention features**, **participant characteristics**, and **study features** (Lustria et al., 2013; Davies et al., 2012).

1. **Intervention Features**: These include the use of theoretical frameworks (e.g., Social Cognitive Theory, Theory of Planned Behavior), behavior change techniques, and communication methods such as text messaging. Studies were examined to determine how the structure and content of the interventions impacted their effectiveness.

2. **Participant Characteristics**: This category includes participant demographics such as age, gender, and health status, which may influence how effective CBHE interventions are for different groups.

3. **Study Features**: Study design, including randomized controlled trials (RCTs) versus quasi-experimental designs, was considered as a moderator. Larger effect sizes are often found in RCTs compared to non-randomized studies (Lustria et al., 2013).

Moderators were evaluated using effect sizes and interaction effects (X^2). The aim was to identify patterns in the effectiveness of CBHE interventions across various health topics and to determine which factors contribute to successful outcomes. Meta-analyses that shared a significant portion of their outcome studies with other reviews were included, provided they offered different moderating features or additional insights into the moderating effects.

Results

Publication Sample

The first literature search retrieved 546 potentially relevant articles. After screening abstracts and full texts (three articles could not be retrieved in full-text form, even after contacting authors), 536 articles were excluded, leaving 10 articles for further analysis. The primary reason for exclusion was that most articles (358) did not focus on CBHE; instead, they related to the use of computers for medical diagnostic purposes. Following the second search, three additional meta-analyses were identified. Two more articles were added after screening reference lists. In total, 15 meta-analyses (Andersson and Cuijpers, 2009; Andrews et al., 2010; Cowpertwait and Clarke, 2013; Davies et al., 2012; Khadjesari et al., 2010; Kodama et al., 2012; Pal et al., 2013; Reed et al., 2011; Reger and Gahm, 2009; Richards and Richardson, 2012; Riper et al., 2011; Riper et al., 2014; Samoocha, et al., 2010; Van Beugen et al., 2014; Wieland et al., 2012) were ultimately included in the review (Table 1/Appendix 1).

Table 1: Overview of Meta-Analyses

Meta-analysis	Theme	Type	Control	Outcome	Duration	Period of Studies
Andersson & Cuijpers, 2009	Depression	ONI	Non-active	Minimal/Regular Symptoms	Pre/post	1990-2009
Andrews et al., 2010	Depression and Anxiety	ONI	Non-active	Symptoms	Pre/post	1990-2010
Cowpertwait & Clarke, 2013	Depression	ONI	Non-active	Regular Symptoms	Pre/post/Follow-up	2002-2010
Davies et al., 2012	Physical Activity	OI	Non-active	Physical activity level	Pre/post/Follow-up	2001-2011
Khadjesari et al., 2010	Alcohol Use	ONI	Non-active	Alcohol consumption/Binge frequency	Pre/post	1997-2008
Kodama et al., 2012	Weight	OI	Regular	Weight loss	Pre/post/Follow-up	2001-2011

Pal et al., 2013	Diabetes Mellitus, type 2	OI	Non-active	Glycaemic control/Dietary change/Weight/Lipids	Pre/post/Follow-up	1986-2011
Reed et al., 2011	Weight	ONI	Regular	Weight loss/BMI	Pre/post/Follow-up	1989-2009
Reger & Gahm, 2009	Anxiety	ONI	Non-active	Regular Symptoms	Pre/post	2000-2007
Richards & Richardson, 2012	Depression	ONI	Non-active	Regular Symptoms	Pre/post/Follow-up	2002-2011
Riper et al., 2011	Alcohol Use	ONI	Non-active	Minimal Alcohol consumption	Pre/post/Follow-up	1997-2011
Riper et al., 2014	Alcohol Use	ONI	Non-active	Minimal Alcohol consumption	Pre/post/Follow-up	2006-2013
Samoocha et al., 2010	Empowerment	OI	Regular	Disease-specific self-efficacy/Empowerment	Pre/post	2002-2009
Van Beugen et al., 2014	Chronic Somatic Conditions	OI	Non-active	Generic psychological/Disease-related impact	Pre/post/Follow-up	2000-2012
Wieland et al., 2012	Weight	ONI	Minimal/Regular	Weight loss/Weight maintenance	Pre/post/Follow-up	1984-2011

OI: Online CBHE intervention; ONI: Online and offline CBHE intervention.

The 15 meta-analyses collectively included 278 studies. Of these, 82% were included in only one meta-analysis, 31 studies appeared in two meta-analyses, 15 studies appeared in three, and 3 studies appeared in four meta-analyses. Two meta-analyses (Cowpertwait & Clarke, 2013; Richards & Richardson, 2012) related to depression included more than two-thirds of the outcome studies from other meta-analyses, and all three studied the same features, though they focused on different aspects.

Meta-analyses were categorized into the following themes: depression and anxiety (5 studies), weight and physical activity (4 studies), substance use (3 studies), and other health themes, including empowerment, diabetes mellitus (type 2), and chronic somatic conditions (1 study each). Five meta-analyses focused solely on online CBHE (including both pure and blended online health education), while the other 10 meta-analyses involved combinations of online and offline CBHE.

Effect of Moderators per Group of Features

Table 2: Effect of Moderators per Group of Features

Moderator	Effect	Number of Meta-analyses/Studies	Result

Intervention Features			
Addition or substitute	Mixed	3/52	Effect (1/23), No effect (2/29)
Content	No effect	1/23	No effect
Focus of treatment	No effect	1/16	No effect
Goal of intervention	Effect	1/23	Effect
Goal setting during intervention	No effect	1/34	No effect
Internet and e-mail	No effect	2/57	No effect
Intervention setting	No effect	4/62	No effect
Length of intervention	Mixed	2/57	Effect (1/23), No effect (1/34)
Mobile intervention	-	1/16	No effect
Study Features			
Sample size	Mixed	2/43	Effect (1/34), No effect (1/9)
Quality	No effect	1/34	No effect

- **Effect**: Significant interaction effect of moderator
- **No effect**: No significant interaction effect of moderator
- **Mixed**: Effect is studied by multiple meta-analyses, results are a mixture of effect and no effect.

Heterogeneity and Publication Bias

All of the meta-analyses reported on heterogeneity, which measures the variation in results beyond what can be expected from chance alone. Five meta-analyses reported non-significant heterogeneity in all their outcomes (Andrews et al., 2010; Khadjesari et al., 2010; Riper et al., 2014; Reed et al., 2011; Samoocha et al., 2010). However, heterogeneity was significant in one or more outcomes of ten meta-analyses (Andersson & Cuijpers, 2009; Cowpertwait & Clarke, 2013; Davies et al., 2012; Kodama et al., 2012; Pal et al., 2013; Reger & Gahm, 2009; Richards & Richardson, 2012; Riper et al., 2011; Van Beugen et al., 2014; Wieland et al., 2012). Heterogeneity was reported as moderate (I^2 = 25%-75%) in seven studies and high (I^2 > 75%) in six studies.

Twelve of the meta-analyses relied solely on randomized controlled trials (RCTs), ensuring higher internal validity (Andersson & Cuijpers, 2009; Andrews et al., 2010; Khadjesari et al., 2010; Reed et al., 2011; Van Beugen et al., 2014). The remaining three meta-analyses incorporated quasi-experimental

studies, quasi-randomized studies, or non-controlled randomized trials alongside RCTs (Davies et al., 2012; Reger & Gahm, 2009; Riper et al., 2014).

Six of the meta-analyses indicated that publication biases could have influenced the results, meaning that studies with beneficial effects were more likely to be published (Davies et al., 2012; Khadjesari et al., 2010; Richards & Richardson, 2012; Riper et al., 2014; Samoocha et al., 2010; Van Beugen et al., 2014). Conversely, six meta-analyses (Andersson & Cuijpers, 2009; Cowpertwait & Clarke, 2013; Kodama et al., 2012; Reed et al., 2011; Reger & Gahm, 2009; Riper et al., 2011) reported that publication biases did not appear to influence the outcomes of their studies. Three meta-analyses (Andrews et al., 2010; Pal et al., 2013; Wieland et al., 2012) did not provide information regarding publication biases.

Findings

Comparison to Active Forms of Traditional Health Education

Seven meta-analyses compared CBHE to active forms of traditional health education, which were defined as care as usual or treatment as usual without the use of a computer or an identical or highly comparable offline intervention. Positive small to moderate significant effects were observed for symptoms of anxiety and depression (Andersson & Cuijpers, 2009; Cowpertwait & Clarke, 2013; Reger & Gahm, 2009; Richards & Richardson, 2012), empowerment, and disease-specific self-efficacy (Samoocha et al., 2010) when compared to the usual treatment or care. In one study, positive effects were demonstrated for CBHE versus treatment as usual for anxiety and depression, although the level of significance was not reported (Andrews et al., 2010). However, one meta-analysis reported non-significant effects for anxiety and depression (Reger & Gahm, 2009). Mixed results were reported for weight loss (Kodama et al., 2012; Reed et al., 2011; Wieland et al., 2012).

Sustainability of Effects

Nine meta-analyses examined long-term effects (Cowpertwait & Clarke, 2013; Davies et al., 2012; Kodama et al., 2012; Reed et al., 2011; Pal et al., 2013; Richards & Richardson, 2012; Riper et al., 2014; Riper et al., 2011; Wieland et al., 2011). All except one (Riper et al., 2014) concluded that CBHE interventions are effective at follow-up. Two meta-analyses related to weight loss revealed that after six months, participants in CBHE interventions had lost more weight than participants in traditional health education programs immediately following the intervention (Kodama et al., 2012; Reed et al., 2011). However, no conclusions could be drawn about longitudinal effects due to the scarcity of studies with follow-up periods greater than six months and the poor quality of follow-up studies (i.e., violating the inclusion criterion of 80% participation at the time of follow-up) (Riper et al., 2014).

Intervention Features

Four intervention features were found to moderate the outcomes of CBHE, although these effects were identified in only one meta-analysis. These moderators included the goal of the intervention (weight loss rather than weight maintenance), the inclusion of more than just instruction (e.g., self-monitoring or email counseling) (Kodama et al., 2012), the use of structured educational material (e.g., exchange of information on changes in physical activity) (Davies et al., 2012), and the delivery of the intervention via mobile phone (Pal et al., 2013).

No relationship with effect was found for six intervention features: focus of treatment, participant recruitment strategy (i.e., community, primary care, or work) (Riper et al., 2014), influence of goal setting, tailoring (i.e., use of fully tailored, partially tailored, or no tailored material), updated content, and the use of quizzes (Davies et al., 2012). Each of these features was studied in only one meta-analysis. Four intervention features showed no effect, and those results were confirmed in at least two meta-analyses. These included: theoretical background (e.g., cognitive behavioral therapy or TTM)

(Andersson & Cuijpers, 2009; Davies et al., 2012), use of only the internet, only email, or both (Davies et al., 2012; Kodama et al., 2012), intervention setting (i.e., home, research location) (Cowpertwait & Clarke, 2013; Pal et al., 2013; Richards & Richardson, 2012; Riper et al., 2011), and self-monitoring (e.g., a tool to monitor physical activity) (Davies et al., 2012; Kodama et al., 2012).

Mixed results were found for six other intervention features. Firstly, interventions supported by a professional resulted in significantly fewer symptoms of depression (Andersson & Cuijpers, 2009; Cowpertwait & Clarke, 2013; Richards & Richardson, 2012) and greater weight loss (Kodama et al., 2012) compared to interventions without professional support (either face-to-face or computer-assisted). This effect was not confirmed for anxiety (Reger & Gahm, 2009) or alcohol use (Riper et al., 2014). Secondly, asynchronous communication (e.g., email) was more effective than synchronous communication (e.g., chat) for depression, but not for physical activity (Davies et al., 2012). Thirdly, CBHE for weight loss was significantly more effective when used as a supplement rather than as a substitute (Kodama et al., 2012), although similar differences in effects were not found for depression and weight loss (Cowpertwait & Clarke, 2013; Reed et al., 2011). Fourthly, interventions for depression were significantly more effective if the number of sessions was fewer than eight rather than eight or more (Richards & Richardson, 2012), while no effect from the number of sessions was observed for physical activity (more or less than ten) (Davies et al., 2012) or alcohol education (a single session versus multiple sessions) (Riper et al., 2014). Fifthly, no impact of duration (less than 6 weeks, 7-12 weeks, and more than 13 weeks) was observed for physical activity (Davies et al., 2012). However, improved effectiveness with longer interventions (more than six weeks) was observed for education related to coping with chronic somatic conditions, although only for the outcome of depression. Lastly, the use of reminders was effective in depression prevention trials (Cowpertwait & Clarke, 2013) but not in physical activity interventions (Davies et al., 2012).

Participant Characteristics

No relationship with effect was observed for individual use of medications independent of the intervention (Cowpertwait & Clarke, 2013) or for the country of study (Kodama et al., 2012), both of which were only studied in one meta-analysis. There was no impact of age (younger or older than 45 years old) or gender (i.e., percentage of participating women) on the effectiveness of interventions; this was confirmed by two meta-analyses (Davies et al., 2012; Kodama et al., 2012).

Mixed results were observed for the influence of the population of participants. A variety of groups were studied in eight meta-analyses (e.g., diagnosed groups versus subclinical groups or students versus non-students). Comparisons were only possible for meta-analyses that investigated the outcome differences between the general population and specific target groups (patients and diagnosed groups) (Davies et al., 2012; Kodama et al., 2012; Richards & Richardson, 2012). A greater effect was found for CBHE for depression in general populations than in specific population groups. This was not observed for physical activity (Davies et al., 2012) or weight (Kodama et al., 2012).

Study Features

No relationship with effectiveness was found for blinding of outcome assessors versus self-report only (Riper et al., 2014), design (randomized controlled trials versus randomized trials) (Davies et al., 2012), publication date (after 1995 versus earlier) (Pal et al., 2013), or quality of cohort studies (fair versus good) (Davies et al., 2012). Each of these study features was only studied in one meta-analysis. The type of analysis also did not moderate effectiveness. Three meta-analyses confirmed that there was no difference between an intention-to-treat versus completers-only analysis (Kodama et al., 2012; Riper et al., 2014; Riper et al., 2011).

Mixed results were observed for sample sizes of the studies. Physical activity trials that included fewer than 35 participants per study reported significantly higher effect sizes than studies with 35 participants

or more. No effect was visible for small (<100) versus large (>100) sample sizes in studies on CBHE for alcohol use (Riper et al., 2011).

Discussions and Conclusions

This systematic review of meta-analyses revealed a positive effect of participation in CBHE and improvements in health-related outcomes compared to treatment or care with traditional health education. The positive effects remain evident for up to 6 months after the intervention. However, the pooled effect sizes were generally small and accompanied by significant (mostly moderate and large) heterogeneity. Both findings point to the need for further investigation into moderators of effect.

This review revealed seven features that did not moderate the effect of the intervention, which was confirmed in at least two meta-analyses. Regarding the other 24 identified features, no consistent results were observed across meta-analyses, or effects were confirmed only in one meta-analysis.

Intervention Features

No evidence of effects was found for four intervention features. First, our results did not confirm differences in effectiveness between CBHE interventions with different theoretical backgrounds. Second, findings revealed that adding email messages to online CBHE interventions does not result in stronger effects. Third, there was no indication that success was related to intervention setting, supporting one of the main benefits of online CBHE: participants can access support at any time and place. Fourth, self-monitoring was not identified as an effective moderator.

Participant Features

This review revealed that the success of CBHE is not moderated by age or gender. Mixed results were observed for the influence of participant populations, with greater effects found for depression in general populations compared to specific population groups.

Study Features

No relationship with effectiveness was found for blinding of outcome assessors, design type, publication date, or cohort study quality. Mixed results were found for sample sizes, with smaller studies on physical activity showing higher effect sizes.

General Moderators of CBHE

Research on moderators has focused on a wide variety of moderators, but many were only studied in single meta-analyses. There is little information on the impact of moderators because moderators are studied as self-contained constructs, and combinations of moderators might be more crucial for improving effectiveness.

Conclusion

CBHE is able to modify participant behavior and create improvements in health. However, more clarity is needed regarding which moderators of effects are responsible for variations, to guide the development, design, and implementation of new and existing CBHE interventions. Identifying domain-specific moderators and their interactions can help optimize the impact of CBHE on health outcomes.

Limitations

First, the use of a box-score approach limited the inclusion of sample sizes and weight factors. Second, the 15 meta-analyses examined a heterogeneous collection of study designs and outcomes, resulting in substantial heterogeneity within the meta-analyses. Third, the exclusion of children and adolescents

limits our ability to control for differences in developmental stages. Finally, the mix of online and offline CBHE in many studies makes it challenging to distinguish between the two forms.

Recommendations for the Future

Future studies should explore moderators of CBHE within individual trials to provide a more detailed understanding of their effects. Additionally, more studies are needed in other domains, such as parental education and sleep disorders. Lastly, systematic reviews of meta-analyses should be conducted with more methodological guidance.

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