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Effectiveness and Outcome Moderators of Computer-Based Health Education for an Adult Population: A systematic Review of Meta-Analytic Studies

***Leontien E. Vreeburg*[1]*, *René F.W. Diekstra*[1] *and Clemens M.H. Hosman*[2]**
The Hague University of Applied Sciences*[1] *and Maastricht University*[2]*/Radboud University Nijmegen*[2]*. The Netherlands
levreeburg@hotmail.com*

Abstract: *This review of meta-analyses of outcome studies of adults receiving Computer-Based Health Education (CBHE) has two goals. The first is to provide an overview of the efficacy of CBHE interventions, and the second is to identify moderators of these effects. A systematic literature search resulted in 15 meta-analyses of 278 controlled outcome studies. The meta-analyses were analysed with regard to reported (overall) effect sizes, heterogeneity and interaction effects. The results indicate a positive relationship between CBHE interventions and improvements in health-related outcomes, with small overall effect sizes compared to non-computer-based interventions. The sustainability of the effects was observed for up to six months. Outcome moderators (31 variables) were studied in 12 meta-analyses and were clustered into three categories: intervention features (20 variables), participant characteristics (five variables) and study features (six variables). No relationship with effectiveness was found for four intervention features, theoretical background, use of internet and e-mail, intervention setting and self-monitoring; two participant features, age and gender; and one study feature, the type of analysis. Regarding the other 24 identified features, no consistent results were observed across meta-analyses. To enhance the effectiveness of CBHE interventions, moderators of effects should be studied as single constructs in high-quality study designs.*

Keywords: Online interventions; computer-based; health; moderator; meta-analytic

Introduction

Various health education programmes are available for people who wish to quit smoking, eat healthier, cope better with stress, and pursue other similar challenges. Health education refers to any combination of learning experiences designed to assist individuals in voluntarily adapting their behaviour to improve their physical or mental health (Green et al., 1981; WHO, 2013). Examples include providing participants with information and skills to reduce symptoms of stress or to influence their behaviour regarding the use of tobacco. The Internet has the ability to educate, to inform and even to encourage people to make significant

changes to their health (Grohol, 2010). This has resulted in the creation of a variety of Computer-Based Health Education (CBHE) interventions. CBHE intervention is an act of health education delivered via the computer either online, offline or a combination of both. Traditional health education intervention refers to the act of health education that does not require the use of a computer.

The effectiveness of CBHE in comparison to traditional health education has been demonstrated by single studies and meta-analyses (Andrews et al., 2010; Spek et al., 2007; Kodama et al., 2012; Reed et al., 2011; Wieland et al., 2012). CBHE interventions are usually compared with an non-active control intervention, such as a waiting list group, instead of an active control, such as care as usual (Andrews et al., 2010; Andersson and Cuijpers, 2009). They tend to focus mainly on effectiveness immediately after the intervention instead of on long-term results (e.g., Barak et al., 2008; Carey et. al., 2009).

Review studies and meta-analyses of CBHE generally compared interventions for a specific application, e.g., smoking cessation, depression or weight control. Few meta-analyses analysed outcome studies of computer-based behaviour change interventions across diverse fields of health education (Lustria et al., 2013; Portnoy et al., 2008; Webb et al., 2010).

All CBHE interventions aim to influence the health behaviour of participants by changing knowledge, attitudes and skills. They are designed by using science-based theories and models (e.g., Social Cognitive Theory (SCT), Theory of Planned Behaviour (TPB) or the transtheoretical model (TTM)) and, therefore, they share the same educational and behavioural principles. All of them share the use of a computer and have the same advantages in terms of possible technological features and face similar difficulties (novelty of the features and accompanied unfamiliarity with use and design, high drop-out rates). Therefore, studying a diverse group of CBHE interventions can provide fruitful insights into more generic mechanisms that make these interventions effective.

Investigating CBHE across multiple applications can yield insight into important issues, such as long-term effectiveness and effectiveness compared to active forms of traditional health education. Furthermore, it can generate new knowledge regarding the development, design and implementation of existing interventions that could be used for interventions in new domains, e.g., online parent education interventions (Nieuwboer et al., 2013).

At this time, there is limited knowledge about which elements or features of CBHE work and for whom they work (Lustria et al., 2009; Morrison et al., 2012). Or, stated differently: what are the factors that affect CBHE interventions and their outcomes (Bauman et al., 2002)?

Theoretical background

Prevention and health promotion literature generally differentiate between three clusters of outcome moderators. A moderator is a qualitative or quantitative variable that affects the direction and/or strength of the relation between an independent variable and a dependent

variable (Baron and Kenny, 1986). The first cluster of moderators are features of interventions (e.g., content and methods of transfer). The second cluster focusses on participants features (e.g., age and gender). The last cluster of moderators is study features (e.g., study designs and sample size) (Lustria, et al., 2013; Davies et al., 2012). The effectiveness of the moderators is calculated in effect sizes. A significant interaction effect shows an effect of a moderator, and no effect when there is no significant interaction effect of moderator. A moderator has a mixed effect, when the effect is studied by multiple meta-analyses and results are a mixture of effect and no effect.

Intervention features

Intervention features such as the systematic use of theories, the use of more behaviour change techniques and the use of additional communication methods, especially text messages, tend to result in larger effects (Webb et al., 2010). Mixed results across meta-analyses (Lustria, et al., 2013; Portnoy et al., 2008) for the moderating effect of tailoring were observed. No effects were found for moderators including user control (i.e., self-guided versus expert guidance), repeated use of assessment tools during an intervention, length of follow-up, retention measures (Lustria, et al., 2013), dosages, use of motivation and behaviour skills techniques, and Internet or CD-ROM (Lustria et al., 2013; Portnoy et al., 2008).

Participant features

Mixed results were found for participant characteristics. According to one meta-analysis, younger participants and females had more success with CBHE interventions (Portnoy et al., 2008), but the moderating roles of age and gender were not confirmed by other meta-analyses (Lustria, et al., 2013; Portnoy et al., 2008). Interventions were more successful if they focused on general populations (e.g., individuals not screened for disease) or on samples within the United States versus non-US samples (Lustria et al., 2013).

Study features

Regarding study features, larger effect sizes were obtained when using randomized controlled trials versus quasi-experimental designs (Lustria, et al., 2013).

In summary, meta-analyses of CBHE interventions have gained limited knowledge on effectiveness of CBHE versus active traditional forms of health education and how sustainable the effects of CBHE are. Meta-analyses were not able to provide unequivocal findings on effective moderators. Results for some factors contradicted each other, as they were only based on one meta-analysis within a single domain, whereas cases with multiple domains were limited until 2010. To gain more insight into this, meta-analyses of CBHE interventions with diverse health foci -resulting in an higher number of outcome studies- allows for a more complete picture.

To study the effectiveness of CBHE for an adult population and its effect moderators and to benefit from the systematic approach of meta-analyses, a systematic review of meta-analyses is presented here. The review focuses specifically on adults, as the content of health education programs needs to be matched with the developmental stage of the participants (Glantz, Rimer and Viswanath, 2008; Resnicow, et al., 2002). This comparison encompasses a huge variety of programs, outcomes and participants. This review expands upon what is known about the effectiveness of CBHE in specific fields and aims to provide more generalized knowledge on moderators of effects to optimize the implementation of successful CBHE programs.

The study aims to identify the effectiveness of CBHE compared to active forms of traditional health education, the long term effectiveness of CBHE and the moderators of effects of CBHE.

Method

Search strategy

Two literature searches were performed by the researchers. Firstly, ERIC, PiCarta, PubMed, PsycArticles, PsycINFO and Academic Search Premier were screened using the search terms listed below. To determine if meta-analyses had been missed in the first search a second search with the search terms was performed using the complete electronic catalogue of Leiden University, as this catalogue covers a broad field of research on education, health and psychology.

Search terms for search one were: 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. In second search the following words 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 selected, meta-analyses had to meet the following criteria:

> (i) Effectiveness must have been studied by calculating a mean effect size based on a comparison of outcomes in the experimental and control conditions. The experimental condition had to concern CBHE, and all forms of control conditions were included. CBHE was defined as health education - any combination of learning experiences designed to assist individuals in voluntarily adapting their behaviour to improve their physical and mental health (Green et al., 1981; WHO, 2013). -

delivered using a computer. This included online interventions, electronic interventions that do not require the Internet (e.g., software), and combinations of both methods. CBHE can be distributed as a purely electronic program or as a blended program (i.e., a combination of an electronic program and a non-electronic intervention). Traditional health education refers to health education that does not require the use of a computer. Active forms of traditional health education are defined as care or treatment as usual without the use of a computer or an identical or highly comparable offline intervention;

(ii) The meta-analyses must have been published between 2008 and July 1, 2014. The field of CBHE is relatively new, and knowledge and experience with CBHE is developing rapidly, therefore a timeframe of six years was chosen;

(iii) The publications must have been written in English and published in peer-reviewed journals;

(iv) Outcomes were required to be measured in terms of the modification of a specific health status of the participant;

(v) All participants had to be adults (i.e., 18 years and older). Meta-analyses that included studies with children, adolescents and/or students (ages not specified) were excluded.

Screening and analysis processes

After removing duplicates, titles and abstracts were scanned to exclude meta-analyses that did not meet the inclusion criteria. Subsequently, the full text versions were searched to further refine the meta-analyses included.

The included meta-analyses were examined by the researchers via a data collection form for meta-analyses adapted from the Cochrane Study Handbook (Higgins & Deeks, 2011).

A specific checklist for analysing meta-analyses for reviews was not found in the literature. Based on Sigman (2011) emphasizing their importance in such an analysis, effect sizes, confidence intervals, heterogeneities, study designs and publication biases were studied. Therefore, a box-score approach is used. Sample sizes and weight factors are not included. The results for effectiveness were reported in effect sizes and 95% confidence intervals. Effect sizes, calculated as standardized mean differences (Cohen's d and Hedges' g), are considered to be small starting at 0.2, medium starting at 0.5 and, finally, large above 0.8 (Cohen, 1992). Comparable cut-off points were not determined for weighted mean differences and Becker's standardized mean gain effect sizes.

Heterogeneity, the variation in the results of individual trials beyond what can be expected from chance alone, (Engels et al., 1999) is reported as I2 (Shadish and Haddock, 1994) and

has a range of 0 to 100%. A value of 0% indicates no heterogeneity, and higher numbers indicate an increase. Thus, 25%, 50% and 75% were considered to be low, moderate and high, respectively (Higgins et al., 2003). Heterogeneity within meta-analyses are studied, to indicate the possibility of combining CBHE of diverse health foci. Systematic reviews of meta-analyses have indicated that 20% of meta-analyses are impacted by publication bias due to studies with beneficial effects having a greater likelihood of getting published compared to those with data pointing in other directions (Delgado-Rodrigues, 2006).

Moderators were clustered into three categories: intervention features, participant characteristics and study features (Lustria et al., 2013; Davies et al., 2012). The effectiveness of moderators of CBHE was studied using effect sizes and interaction effects (X^2).

Meta-analyses that shared more than half of their outcome studies with another meta-analysis were included when they provided different moderating features and when they were not the only meta-analysis providing information about those features.

Results

Publication sample

The first search retrieved 546 potentially relevant articles. After screening abstracts and full texts (three articles could not be retrieved in full-text form, after e-mailing authors), 536 articles were excluded and 10 articles remained. Most of the articles (358) were disqualified because they did not focus on CBHE; in most, a computer was used for medical diagnostic purposes. After the second search, three meta-analyses were added. Two articles were added after screening reference lists. In the end, 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 identified and included (Tables I/Appendix I).

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 Minimal Regular	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 Minima	Alcohol consumption	Pre/post Follow-up	2006-2013
Samoocha, et al., 2010	Empowerment	OI	Regular	Disease-specific self-efficacy Empowerment General self-efficacy Mastery Self-esteem	Pre/post	2002-2009
Van Beugen, et al., 2014	Chronic somatic conditions	OI	Non-active Regular	Generic psychological Disease specific physical Disease related impact on daily life	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 offlline CBHE intervention

The 15 meta-analyses encompassed 278 studies. Of those studies, 82 percent were only included in one meta-analysis, 31 studies were examined in two meta-analyses, 15 studies were included in three meta-analyses, and three studies were included in four meta-analyses. Two meta-analyses (Cowpertwait and Clarke, 2013; Richards and Richardson, 2012) related to depression included more than two-thirds of the outcome studies used in other meta-analyses and studied the same three features. They studied different aspects of these features, and all three features were also studied by other meta-analyses.

Meta-analyses are clustered into depression and anxiety disorders (5), weight & physical activity (4), substance use (3), and other health themes, including empowerment diabetes mellitus, type 2 (1) and chronic somatic conditions (1). Five meta-analyses focus solely on online CBHE, including both pure and blended online health education; the other ten are combinations of online and offline CBHE. Twelve meta-analyses provide calculated effects of moderators (Table 1/2)

Table 2: Effect of moderators per group of features

	Effect differentiated by number of meta-analysis/number of outcome studies
Intervention features	
Addition or substitute	Mixed (3/52); Effect (1/23); No effect (2/29)
Content	No effect (1/23)
Focus of treatment	No effect (1/16)
Goal of intervention	Effect (1/23)
Goal setting during intervention	No effect (1/34)
Internet and e-mail	No effect (2/57)
Intervention setting	No effect (4/62)
Length of intervention	Mixed (2/57); Effect (1/23); No effect (1/34)
Mobile intervention	- (1/16)
Number of sessions	Mixed (3/69); Effect (1/19); No effect (2/50)
Online communication	Mixed (2/53); Effect (1/19); No effect (1/34)
Recruitment	No effect (1/16)
Reminders	Mixed (2/52); Effect (1/18); No effect (1/34)
Self-monitoring	No effect (2/57)
Structured educational material	Effect (1/34)
Support of professional	Mixed (7/116); Effect (5/81); No effect (2/35)
Tailoring	No effect (1/34)
Theoretical background	No effect (2/46)
Updated content	No effect (1/34)
Quizzes	No effect (1/34)
Participant characteristics	
Age	No effect (2/57)
Country of origin	No effect (1/23)
Gender	No effect (3/73)
Population	Mixed (7/165); Effect (2/43); No effect (5/122)
Medication allowed	No effect (1/18)
Study features	
Blinding	No effect (1/16)
Design	No effect (1/34)
Publication date	No effect (1/11)
Sample size	Mixed (2/43); Effect (1/34); No effect (1/9)
Type of analysis	No effect (3/48)
Quality	No effect (1/34)

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.
- For mobile interventions no interaction effects are reported.

All of the meta-analyses reported on heterogeneity. Five meta-analyses report non-significant heterogeneity in all of their outcomes (Andrews et al., 2010; Khadjesari et al., 2010; Riper et al., 2014, Reed et al., 2011; Samoocha, et al., 2010). Heterogeneity is significant in one or more outcomes of ten meta-analyses (Andersson and Cuijpers, 2009; Cowpertwait and Clarke, 2013; Davies et al., 2012; Kodama et al., 2012; Pal et al., 2013; Reger and Gahm, 2009; Richards and Richardson, 2012; Riper et al., 2011; Van Beugen et al., 2014; Wieland et al., 2012): the I2 is moderate in seven studies (Andersson and Cuijpers, 2009; Cowpertwait and Clarke, 2013; Davies et al., 2012; Pal et al., 2013; Reger and Gahm, 2009; Van Beugen et al., 2014; Wieland et al., 2012) and high in six (Cowpertwait and Clarke, 2013; Kodama et al., 2012; Pal et al., 2013; Reger and Gahm, 2009; Richards and Richardson, 2012; Riper et al., 2011). Twelve meta-analyses only used randomized controlled studies (Andersson and Cuijpers, 2009; Andrews et al., 2010; Khadjesari et al., 2010; Reed et al., 2011; Van Beugen et al., 2014).

The other three also included quasi-experimental studies (Davies et al., 2012; Reger and Gahm, 2009), quasi-randomized studies (Riper et al., 2014) and non-controlled randomized trials (e.g., included randomization procedures, but no true control group) in addition to randomized controlled studies (Davies et al., 2012).

Six meta-analyses concluded that the data should be interpreted with care because of possible publication biases (Davies et al., 2012; Khadjesari et al., 2010; Richards and Richardson, 2012; Riper et al., 2014; Samoocha, et al., 2010; Van Beugen et al., 2014). Six meta-analyses (Andersson and Cuijpers, 2009; Cowpertwait and Clarke, 2013; Kodama et al., 2012; Reed et al., 2011; Reger and Gahm, 2009; Riper et al., 2011) reported that publication biases did not influence the effects.

Three meta-analyses did not provide information regarding publication biases (Andrews et al., 2010; Pal et al., 2013; Wieland et al., 2012).

Findings

Comparison to active forms of traditional health education

Seven meta-analyses compared CBHE to active forms of traditional health education, 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 reported for symptoms of anxiety and depression (Andersson and Cuijpers, 2009; Cowpertwait and Clarke, 2013; Reger and Gahm, 2009; Richards and Richardson, 2012), empowerment and disease-specific self-efficacy (Samoocha, et al., 2010) compared to the usual treatment or care. In one study, positive effects were demonstrated for CBHE versus treatment as usual for anxiety and depression, but the level of significance was not reported (Andrews et al., 2010). One meta-analysis reported non-significant effects for anxiety and depression (Reger and 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 and Clarke, 2013; Davies et al., 2012; Kodama et al., 2012; Reed et al., 2011; Pal et al., 2013; Richards and 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 health education programs directly after the intervention (Kodama et al., 2012; Reed et al., 2011). No conclusions about longitudinal effects could be drawn due to the scarcity of studies with follow-up periods of greater than six months in the meta-analyses (Davies et al., 2012; Richards and Richardson, 2012) and the poor quality of follow-up studies (i.e., violating the inclusion criterion of 80% participating at the time of follow-up) (Riper et al., 2014).

Intervention features

Four intervention features were found to moderate the outcomes of CBHE, though these effects were only identified in one meta-analysis. The moderators were goal of the intervention (weight loss instead of weight maintenance), intervention provided more than just instruction (e.g., self-monitoring or e-mail counselling) (Kodama et al., 2012), structured educational material (i.e., exchange of information on changes in physical activity) (Davies et al., 2012), and intervention was delivered by mobile phone (Pal et al., 2013).

No relationship with effect was reported 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 use of quizzes (Davies et al., 2012). Each of those 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. Moderators included: theoretical background (e.g., cognitive behavioural therapy or TTM) (Andersson and Cuijpers, 2009; Davies et al., 2012), the use of only the internet, only e-mail or both (Davies et al., 2012; Kodama et al., 2012), intervention setting (i.e., home, a research location) (Cowpertwait and Clarke, 2013; Pal et al., 2013; Richards and 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. First, interventions supported by a professional resulted in significantly fewer symptoms of depression (Andersson and Cuijpers, 2009; Cowpertwait and Clarke, 2013; Richards and Richardson, 2012) and greater weight loss (Kodama et al., 2012) compared to interventions without this support (either face-to-face or by computer). This was not confirmed for anxiety (Reger and Gahm, 2009) or alcohol (Riper et al., 2014). Second, asynchronous communication (e.g., e-mail) was more effective [33] than synchronous communication (e.g., chat) for depression, but not for physical activity (Davies et al., 2012). Third, CBHE for weight loss is significantly more

effective when used as a supplement rather than as a substitute (Kodama et al., 2012), but similar differences in effects were not found for depression and weight loss (Cowpertwait and Clarke, 2013; Reed et al., 2011). Fourth, interventions for depression were significantly more effective if the number of sessions was lower than 8 instead of 8 or more (Richards and Richardson, 2012), while no effect from the number of sessions was observed for physical activity (more or less than 10) (Davies et al., 2012) and alcohol education (a single session versus multiple sessions) (Riper et al., 2014). Fifth, 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 [37]. Finally, the use of reminders was effective in depression prevention trials (Cowpertwait and Clarke, 2013) but not in physical activity interventions (Davies et al., 2012).

Participant characteristics

No relationship with effect were observed for individual use of medications independent of the intervention (Cowpertwait and Clarke, 2013) or for 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 and 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 [20]. 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 an investigation of 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. Earlier research showed larger effect sizes for TPB when compared with TTM or SCT; however, TPB is regarded as a predictive model instead of as a model of behavioural changes and they found incorrect claims of manuscripts regarding usage of TPB (Webb et al., 2010). Second, our findings revealed that adding e-mail messages to online CBHE interventions does not result in stronger effects. Earlier research demonstrated the benefits of text messages, personal contact via the e-mail could help to support behaviour change (Webb et al., 2010). This result might suggest that e-mail is not an additional educational method per se only if it provides personal contact to participants. Third, our findings give no indication that success of CBHE is related to intervention setting. This finding supports one of the main benefits of online CBHE: participants can be helped at any time and place. Fourth, self-monitoring was not identified as an effective moderator. Earlier research revealed that self-monitoring was one of the most commonly used behaviour change techniques, but it also showed that it had no effect on the success of interventions (Webb et al., 2010). They demonstrated that the number of behaviour change techniques used had a significant impact on the success of the intervention. None of the meta-analyses in our review focused on the number of techniques used, and the moderating role of only a few of the behaviour change techniques was studied. Commonly used behaviour change techniques, such as modelling, feedback and stress management, were not studied by the meta-analyses in this review.

Participant features

This review revealed that the success of CBHE is not moderated by age and gender. Regarding age, our findings are in accordance with Lustria and colleagues (2013). However,

earlier meta-analyses found that young adults (Davies et al., 2012; Moreno, Reislein and Ozogul, 2010) gain more from online CBHE interventions than older adults (Barak et al., 2008; Portnoy et al., 2008; Sitzmann et al., 2006). The meta-analyses in this review cannot confirm a possible digital divide between generations. Regarding gender, our results confirmed the findings of the excluded meta-analyses [Carey et al., 2009; Lustria et al., 2013; Rooke et al., 2010; Tait, Spijkerman and Riper, 2013). The role of gender might be dependent on the issue the intervention is addressing. For example, in depression, the onset and prevalence are much higher among women than men (WHO, 2008). As a consequence, women might benefit much more than men from depression interventions. In traditional depression programmes, larger effects were found for female children and adolescents in a meta-analytic review (Stice et al., 2009), but there was no evidence that gender had a moderating role in an adult programme (Rohrle, 2013). In one meta-analysis, more effects were observed when the number of male participants was higher (Jane-Llopis et al., 2003).

Study features

No differences in effects were found between the two types of analyses, namely, intention-to-treat and completers-only in two alcohol meta-analyses and one weight meta-analysis. This absence of effects could reveal that there is no overestimation of effects.

General moderators of CBHE

A number of notable findings regarding general aspects of moderators were observed. First, research has focused on a variety of moderators instead of investigating specific moderators thoroughly. This review revealed 31 outcome moderators, but more than half of these moderators were studied in only one meta-analysis (n=17). Second, although a variety of moderators were studied, some obvious moderators, including animated pedagogical agents (Moreno, Reislein and Ozogul, 2010), ask-the-expert services (Morrison et al., 2012) and well-known moderators of traditional interventions such as income, education and SES (Lundahl, Risser and Lovejoy, 2006) were not studied as effect moderators. Thirdly, there is little information on the impact of moderators because moderators are studied as single self-contained constructs. However, it is quite likely that combinations of moderators and interactions between moderators could be crucial for improving effectiveness. For example, neither gender nor age consistently moderated the effects of interventions. However, a combination of both might influence intervention effects. A gender effect could be present in middle-aged and elderly people but not among young adults, who have all grown up with the Internet.

In conclusion, CBHE is able to modify the behaviour of participants and create improvements in their lives. More clarity regarding which moderators of effects are responsible for variations in effects is needed for the development, design and implementation of existing and new CBHE interventions and for the determination of whether common moderators are effective across CBHE interventions or if they are domain-specific.

Limitations

First, systematic reviews of meta-analyses are uncommon, and little methodological guidance is available for conducting such reviews. This is why we used a box-score approach after consulting with experts. This means that we did not account for sample sizes and weight factors. Second, the 15 meta-analyses examined a heterogeneous collection of study and participant samples, outcomes measures and methodological designs. In addition to heterogeneity between meta-analyses, this review also has heterogeneity within meta-analyses. Heterogeneity was found to be significant in one or more outcomes in nine meta-analyses. This indicates that there are differences between those studies and that it may not be valid to pool the results. Third, meta-analyses of outcome moderators relate differences in participant and intervention characteristics in whole trials to outcome differences between studies. This only offers partial information about the available empirical evidence regarding the influence of such moderators. It does not include information from many studies that have tested the moderating role of participant characteristics and intervention features within such trials. Fourthly, children and adolescents were excluded in this comparison to control for differences in developmental stages. However, we are not able to control between stages in adulthood such as young and late adulthood. Fifthly, a substantial number of meta-analyses (n=10) included a mixture of online and offline CBHE. As a result, it is difficult to distinguish between both forms. This could, for the most part, be a distinction between older and newer programs, as purely online programs are more recent. A meta-analysis investigating the impact of the publication date showed no difference between interventions published earlier and later [6]. Finaly, the use of internet is changing rapidly. It is more common to have blended health education interventions, there are new ways of CBHE available, like mobile health interventions and games. Also, the users are changing and are more skilled in using the internet. These changes can be an influencing factor, and should be taken into account.

Recommendations for the future

The authors would like to highlight three recommendations. First, meta-analyses are limited in their potential to identify common moderators of effects. To create a more extensive source of information on moderators, meta-analyses should study not only moderators of outcome variance between trials but also the results from moderator analyses performed within trials. Therefore, a systematic investigation of effects of moderators is needed in primary studies. At the moment, few individual studies have isolated moderators and studied them in high-quality study designs (Davies et al., 2012; Stice et al., 2009). Second, the effectiveness of online CBHE was demonstrated in commonly studied topics, such as depression. To demonstrate that CBHE is a viable alternative in other domains, studies in other domains, such as parental education or sleeping disorders, are needed. Third, systematic reviews of meta-analyses are uncommon, although they could be an appropriate alternative to a literature review when a meta-analysis of meta-analyses is not an adequate research method. More methodological guidance is needed to adequately perform it.

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Appendices

Appendix 1. Overview of the effectiveness of the meta-analyses per outcome, control condition and follow-up

Authors and year	**Studies & participants**	**Focus**	**Out-come**	**Pooled effect versus comparison group & follow-up**	**Effect size[a] & Confidence interval[b]**	**Heterogeneity[c]**
Andersson & Cuijpers 2009	12 2446	Depres sion	Symptoms	Pooled ONI vs. care-as-usual (5) ONI vs. waitlist (7) ONI vs. other control group (3)	d=0.41**** (0.29-0.54) d=0.23*** (0.06–0.40) d=0.56**** (0.37–0.76) d=0.45 ****(0.21–0.69)	I^2=57.49*** I^2=46.34 I^2=43.51 I^2=59.38*
Andrews, et al., 2010	22 1746	Depres sion and anxiety	Symptoms Major depression	Pooled ONI vs. waitlist (18) ONI vs. treatment as usual/other	g=0.88**** (0.76-0.99) g=0.94 (0.81–1.07)[e] g=0.75	I^2=7.84 - - I^2=0 I^2=0

			(6) Social phobia (8) Panic disorder (6) GAD (2)	control (4)	(0.51–0.98)[e] g=0.78**** (0.59-0.96) g=0.92**** (0.74-1.09) g=0.83**** (0.45-1.21) g=1.11**** (0.76-0.99)	I^2=0 I^2=0
Cowpertwait & Clarke 2013	18 2946	Depression	Symptoms Well-being (9)	Pooled ONI vs. treatment as usual (8) ONI vs. waitlist (8) ONI vs. placebo (2) Pooled Follow-up (8)	g=0.43*** (0.29-0.57) g=0.40*** (0.31-0.49) g=0.34** (0.22-0.46) g=0.51*** (0.35-0.67 g=0.37** (0.13-0.61) B=1.12*** (0.87-1.37)	Q=48.60**** (I^2=65.55) Q=36.16**** (I^2=74.88) Q=48.80**** (I^2=88.55)
Davies, et al., 2012	34 9638	Physical activity	Physical activity level	Pooled Follow-up 6 months (11) Intervention group (4) Minimal intervention (4) Standard care (9) Control group (17)	d=0.14***(0.09-0.19) d=0.11** No CI reported d=0.03 (-0.08-0.14) d=0.43** (0.21-0.66) d=0.16** (0.09-0.23) d=0.14** (0.07-0.20)	Q=73.75**** (I^2=55.25) - Qw=1.76 Qw=5.80 Qw=23.23*** (I^2=65.56) Qw=32.46
Khadjesari, , et al., 2010	24 -	Alcohol use	Quantity (in grams ethanol) Binge frequency per week (in days)	ONI vs. minimal active comparator (16) (waitlist, assessment) ONI vs. active comparator	WMD=-25.9**** (-41--11)[f] -WMD=0 -.23* (-.47-0.00)[f]	I^2=62 I^2=0

				(3)	-	
				ONI vs. minimal active comparator (5)		
				ONI vs. active comparator (2)		
Kodama, et al., 2012	23 8697	Weight	Weight loss (in kilogram)	OI vs. offline (23)	WMD=-0.68 (-1.29- -0.08)**[f]	I²=84.4****
				Follow-up < 6 months (9)	WMD= -1.55 (-2.05- -1.05)***[f]	
				Follow-up ≥ 6 to <12 months (8)	WMD=-0.39 (-1.38-0.60)[f]	
				Follow-up ≥ 12 months (8)	WMD= -0.20 (-1.46-1.06)[f]	
Pal, et al., 2013	16 3578	Diabetes mellitus, type 2	Glycaemic control	Pooled (11)	MD=-0.21***(-0.37- -0.05)	I²= 58***
				Change in mean (3)		I²= 60**
				Mean difference (8)		I²= 56**
				Follow-up < 6 months (5)	MD=0.06 (-0.27-0.39)	I²=43
			Dietary changes	Follow up ≥ 6 months (6)	MD=-0.32*** (-0.52- -0.12)	I²=61
				Fruit & vegetable screener score (1)	MD=-0.32*** (-0.58- -0.07)	-
			Weight	Estimated daily fat intake (2)	MD=-0.14(-0.33-0.05)	I²=81**
				Change in calorific intake (1)		-
			Lipids	Pooled effect on diet (3)	MD=0.60 (-0.35-1.55)	I²=46
				Estimated daily fat intake (2)	MD=-3.44 (-7.93-1.05)	-
				Change in weekly calory intake (1)	-	I²=0
				Weight (3)	MD=-0.29**** (-0.43- -0.15)	-
				Change in weight (1)		I²=0
				BMI (1)	MD=-0.32**** (-0.49- -	-
				Total cholesterol		-

				(TC) (4) Change in TC (1) High density lipoprotein (HDL) (2) Change in HDL (1) Low density lipoprotein (LDL) Change in LDL (1) TC:HDL ratio (3) Change in triglycerides (1) Pooled effect on cholesterol (7) Total cholesterol (4) Change in total cholesterol (1) TC: HDL	0.16) MD=-0.23* (-0.46-0.01) SMD=-0.05 (-0.22-0.13) SMD=-0.14 (-0.38-0.09) SMD=-0.06 (-0.31-0.19) MD=-0.19*(-0.41-0.02) - MD=-0.01 (-0.08-0.05) - - - MD=0.05 (-0.07-0.16) - SMD=-0.11 (-0.28-0.05) SMD= -0.22* (-0.48-0.04) SMD=-0.27** (-0.50- -0.03) SMD=0.06 (-0.08-0.20)	
Reed, et al., 2011	11 1866	Weight	Weight loss (in kilogram) BMI (in kilogram /m2)	ONI vs. identical or highly comparable Offline intervention (5) Follow-up < 6 months (2) Follow-up ≥ 6 months (1) ONI vs.	WMD=-1.47**(-0.13--2.81)[f] WMD=-1.95***(-3.500.40)[f] WMD=-1.08 (-	I^2=0 I^2=0 I^2=0 I^2=0

				identical or highly comparable Offline intervention (3)	2.50-0.34)[f] WMD=-0.44(-1.15- -2.03)[f]	
Reger & Gahm, 2009	19 1170	Anxiety	Overall	ONI vs. waitlist (10)	d=0.76** (0.60-0.92)	Q=15.23 Q=5.80 Q=13.12** I^2=54.27
			Symptoms of anxiety	ONI vs. placebo (7)	d=0.86**(0.61-1.11)	Q=18.08** I^2=50.22 Q=6.83 Q=13.46** I^2=55.42
				ONI vs. treatment as usual (7)	d=0.03 (-0.35-0.41)	Q=6.02 Q=1.67 Q=0.95
			Symptoms of depression	ONI vs. waitlist (10)	d=0.77**(0.56-0.98)	Q=2.82 Q=0.29 - Q=17.42** I^2=82.78
				ONI vs. placebo (6)	d=0.88** (0.70-1.31)	Q=0.28 Q=1.25 Q=4.20
				ONI vs. treatment as usual (7)	d=0.00 (-0.38-0.38)	Q=0.27 Q=4.99
			Level of general distress	ONI vs. waitlist (8)	d=0.89** (0.69-1.08)	
				ONI vs. placebo (4)	d=0.49** (0.14-0.84)	
				ONI vs. treatment as usual (3)	d=0.57** (0.22-0.92)	
			Level of dysfunctional thinking	ONI vs. waitlist (4)	d=0.48** (0.24-0.72)	
				ONI vs. placebo assignment (2)	d=-0.58** -d=1.14** (0.43-1.85)	
				ONI vs. treatment as usual (0)	d=0.70** (0.26-1.15)	
			Level of quality of life	ONI vs. waitlist (4)	d=0.25 (-0.02-0.53)	
				ONI vs. placebo 3)	d=0.57** (0.23-0.91)	
				ONI vs. treatment as usual (4)	d=0.71** (0.29-1.14)	
					d=-0.02 (-0.33-0.30)	
Richards & Richardson, 2012	19 2996	Depression	Symptoms	Pooled Follow-up (14) 1 month to 1 year	d=0.56*** (-0.71-0.41)	I^2=81****

				ONI vs. waitlist (8) ONI vs. treatment as usual (8)	d=0.20****(-0.31-0.09) d=0.68***** (-0.85 - 0.52) d=0.39****** (-0.66- - 0.12)	
Riper, Spek, Boon et al., 2011	9 1553	Alcohol use	Alcohol consumption	Pooled Pooled (exclusion 2 outliers; follow up 6-9 months) ONI vs. assessment-only (1) ONI vs. waitlist (2) ONI vs. alcohol leaflet (4)	g=0.44******(0.17-0.71)[f] g=0.39*****(0.23-0.57)[f] g=0.12(-0.84-1.07) g=0.77 (0.19-1.34) g=0.35 (0.21-0.48)	Q=42.30, I^2=81.08****** Q=8.19, I^2=26.75 - - -
Riper, , et al., 2014	16 5612	Alcohol use	Alcohol consumption	Pooled Follow-up (6) ONI vs. assessment-only (11) ONI vs. waitlist (3) ONI vs. alcohol brochure (9)	g=0.20*****(0.13-0.27) g=0.06 (-0.14-0.25) g=0.15*****(0.06-0.24) g=0.48*****(0.22-0.73) g=0.20*****(0.08-0.31)	I^2=27 I^2=0 I^2=0 I^2=48
Samoocha, et al., 2010	14 3471	Empower-ment of patients (diverse groups e.g., infertility, post-traumatic stress disorder, diabetes, back pain)	Empowerment (2) Disease-specific self-efficacy (9) General self-efficacy (3) Mastery (1) Self-esteem (1)	OI vs. usual care[i] OI vs. usual care[i] OI vs. usual care OI vs. usual care OI vs. face-to-face OI vs. usual care OI vs. face-to-face	SMD=0.61******(0.29-0.94) SMD=0.23******(0.12-0.33) SMD=0.05 (-0.25-0.35) SMD=2.95 (1.66-4.24) SMD=1.20 (-	I^2=0 I^2=27 I^2=27

					1.73-4.13) SMD=-0.38 (-2.45-1.69) SMD=-0.10 (0.45-0.25)	
Van Beugen, et al., 2014	23 4340	Chronic somatic conditions	General psychological Depressive symptoms (15) Anxious symptoms (10) General distress (6) Disease related physical Irritable bowel syndrome symptoms (2) Headache (3) Sleep quality (3) Pain (6) Fatigue (2) Tinnitus loudness (2) Glycemic control (2) Disease related impact on daily life Disease-specific quality of life(3)	OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control OI vs. passive control	SMD=0.21****(0.08-0.34) SMD=0.17**(0.01-0.32 SMD=0.21* (0.00-0.41) SMD=1.19**** (0.82-1.57) SMD=0.49**** (0.21-0.77) SMD=0.25* (-0.02-0.53) SMD= 0.18**** (0.08-0.28) SMD=0.15*** (0.05-0.26) SMD=-0.04 (-0.40-0.32) SMD=0.07 (-0.17-0.30) SMD=1.11**** (0.79-1.44) SMD=0.17 (0.03-	I²=29 I²=0 I²=0 I²=0 I²=0 I²=0 I²=0 I²=0 I²=62 I²=0 I²=57**

					0.31)	
			Disease-specific distress (6)			
Wieland et al., 2012	18 4140	Weight (in kg)	Weight loss after 6 months (14) Weight maintenance after six months (4)	ONI vs. minimal control (2) ONI vs. in-person treatment (1) ONI vs. minimal control (2) ONI vs. in-person treatment (2)	WMD=-1.5**** (-2.1-0.9)[f] WMD=2.1*** (0.8-3.4)[f] WMD=-0.7*** (-1.2—0.2) [f] WMD=0.5 (-0.5-1.6)	I^2=0 I^2=0* I^2=66*

*p<.10 **p<.05 ***p<.01 ****p<.001
OI=Online CBHE intervention; ONI= Online and offline CBHE intervention
a) Effect sizes; d=Cohen's d; g= Hedges' g; SMD= Standardized mean difference (unclear Cohen's d or Hedges' g); WMD= weighted mean difference; B=Becker's standardized mean gain effect size.
b) Confidence interval is 95%;
c) Heterogeneity is calculated as Q or I^2
e) No significance reported
f) Negative number indicates positive effects (weight loss or less alcohol consumption) and positive number indicates negative effects (weight gain or greater alcohol consumption)

Appendix 2: Interaction effects per intervention feature

Addition or substitute	*Depression (18 studies)* [29] TAU in addition Yes (5) g=0.36**** (0.27-0.45) No (10) g=0.55**** (0.45-0.65) Non-sign. interaction	*Weight (23 studies) [6]* Role internet Additional support (23) WMD=-1.00 (-1.57- -0.43)**** Substitute for personal support (8) WMD=1.27 (0.29-2.25)** Interaction****	*Weight (11 studies) [7]* Addition of computer (6) WMD: -1.48*** (-2.52- -0.43) Substitution of computer (6) WMD: 0.36 (-1.80-2.53) Substitution of computer (5) excl one outlier WMD: 1.47** (0.13-2.81) Non-sign. interaction	
Content & Instruction	*Weight (23 studies) [6]* Content of web-based interventions included other than instruction No (9) WMD=-1.33 (-2.32- -0.34)*** Yes (16) WMD=-0.25 (-0.98-0.47) Interaction*			

Focus of treatment	*Alcohol (16 studies)[34]* Personalised Normative feedback (9) g=0.16****(0.07-0.24) Combined (14) g=0.24**** (0.13-0.35) Non-sign. interaction			
Goal of intervention	*Weight (23 studies) [6]* Aim of using internet Weight loss (20) WMD=-1.01 (1.68- -0.34)** Weight maintenance (5) WMD=0.68(-0.50-0.85) Interaction**			
Goal setting during intervention	*Physical activity (34 studies) [20]* Goal setting Yes (19)d=0.16*** (0.10-0.22) No (15)d=0.12*** (0.06-0.12) Non-sign. interaction			
Internet and e-mail	*Physical activity (34 studies) [20]* Internet and e-mail (21) d=0.16 (0.09-0.23) Only internet OR e-mail (13) d= 0.13 (0.08-0.18) Non-sign. interaction	*Weight (23 studies [6]* Included e-mail counseling in addition to instruction No (10) WMD=-1.05 (-1.90- -0.21)** Yes (15) WMD=-0.17 (-1.09- 0.75) Non-sign. interaction		
Intervention setting	*Alcohol use (9 studies) [35]* Home (2) g=0.47 (0.25-0.69) ⌘ Research, health center, or workplace setting (5) g=0.39 (0.15-0.63) ⌘ Non-sign. interaction	*Depression (18 studies) [29]* Community (13) g=0.40**** (0.32-0.48) Primary care (3) g=0.60**** (0.43-0.52) Secondary care (2) g=0.25* (0.10-0.40) Non-sign. interaction	*Depression (19 studies) [33]* Community (12) d=0.60**** (-0.76- -0.44) Primary-secondary care (7) d=0.46** (-0.84- -0.09) X^2=0.08	*Diabetes Mellitus (16 studies) [31]* Home (4) MD=-0.25** (-0.47- -0.04) No interaction effect reported
Length of intervention	*Physical activity (34 studies) [20]* 0-6 weeks (8) d=0.11*** (0.03-0.19) 7-12 weeks (17)d=0.13*** (0.08-	*Chronic somatic (23 studies) [37]* ≤6 weeks (7) SMD=0.08 (-0.05-0.22) ⌘ >6 weeks (8) SMD=0.29 (0.13-		

	.19) 13+ weeks (8) d=0.21***(0.09-0.33) Non-sign. interaction	0.46) ⌘ X^2=3.91* Only for depression outcome		
Mobile intervention	*Diabetes Mellitus (16 studies) [31]* Mobile phone (3) MD=-0.50****(-0.74- -0.26) No interaction effect reported			
Number of sessions	*Depression (19 studies) [33]* <8 sessions(9) d=0.75****(-1.02- -0.49) ≥ 8 sessions (10) d=0.39****(-0.56- -0.22) X^2=7.48***	*Physical activity (34 studies) [20]* < 10 sessions (22) d=0.13*** (0.07-0.18) ≥10 sessions (10) d=0.18*** (0.10-0.25) Non-sign. interaction	*Alcohol (16 studies) [34]* Single (8) g=0.16**** (0.08-0.25) More than 1 (15) g=0.22**** (0.12-0.33) Non-sign. interaction	
Online communication	*Depression (19 studies) [33]* Asynchronous (8)d=0.70**** (-0.85- 0.55) Synchronous (2) d=0.28** (-0.91-0.35) X^2=1.64**	*Physical activity (34 studies) [20]* Asynchronous communication Yes (15)d=0.16*** (0.09-0.23) No (19)d=0.13*** (0.08-0.18) Non-sign. interaction		
Recruitment	*Alcohol (16 studies) [34]* Community (11) g=0.21****(0.11-0.31) Primary care/clinic (7) g=0.21*** (0.04-0.39) Work (5) g=0.24***(0.05-0.412) Non- sign. interaction			
Reminders	*Depression (18 studies) [29]* Reminders Yes (13) g=0.49**** No (5) g=0.24*** Interaction **	*Physical activity (34 studies) [20]* E-mail reminders Yes (22)d=0.15*** (0.09-0.21) No (12)d=0.13*** (0.07-0.19) Non-sign. interaction		
Self-monitoring	*Physical activity (34 studies) [20]* Self-monitoring Yes (18)d=0.20*** (0.13-0.27) No (16)d=0.11*** (0.06-0.16) Non-sign. interaction	*Weight (23 studies)[6]* Content of web-based interventions included self-monitoring in addition to		

		instruction No (12) WMD=-1.15 (-1.88 - 0.42)*** Yes (13) WMD=-0.14 (-1.06-0.79) Non-sign. interaction		
Structured educational material	*Physical activity (34 studies) [20]* Yes (24) d=0.20*** (0.14-0.26) No (10) d=0.08 (0.01-0.14) Interaction***			
Support of professional	*Alcohol use (9 studies) [35]* Type of treatment Single session E-personalized normative feedback (4) g=0.27 (0.11-0.43) ⌘ E-self help intervention (3) g=0.61 (0.33-0.90) ⌘ Interaction**	*Anxiety (19 studies) [32]* Waitlist control Face-to-face clinical contact (3) d=0.91 (0.61-1.21) ⌘ No clinical contact (7) d=0.70 (0.50-0.89) ⌘ Non-sign. interaction placebo controlled studies Face-to-face clinical contact (3) d=0.91 (0.61-1.21) ⌘ No clinical contact (4) d=0.85 (0.51-1.18) ⌘ Non-sign. interaction TAU-controlled studies Face-to-face clinical contact (5) d=0.04 (-0.22-0.31) ⌘ No clinical contact (2) d=0.26 (-0.17-0.68) ⌘ Non-sign. interaction	*Depression (12 studies) [9]* Professional support Support (8) d=0.61 (0.45-0.77)**** No professional support (7) d=0.25 (0.14-0.35)**** Interaction****	*Depression (18 studies)[29]* Treatment type Human-supported (11) g=0.48**** (0.39-0.57) Self-guided (7) g=0.32**** (0.23-0.41) Interaction*
Support of professional (continued)	*Depression (18 studies) [29]* Human support None (5) g=0.29*** Feedback only (5) g=0.47**** Engagement (7) g=0.57****	*Depression (19 studies)*[j] Therapist support (7) d=0.78**** (-0.92 - -0.64) Administrative support (5)	*Weight (23 studies) [6]* In-person counseling added to web-based intervention? No (17) WMD=-0.19 (-0.87- 0.49)	*Alcohol (16 studies) [34]* Guided (5) g=0.23***(0.05-0.41) Unguided (18) g=0.20****(

	Interaction**	d=0.58**** (-0.88- -0.28) No support (9) d=0.36*** (-0.61- -0.10) X^2=7.86** (no versus therapist support)	Yes (9) WMD=-1.93 (-2.71- -1.15)**** Interaction***	0.12-0.28) Non-sign. interaction
Tailoring	*Physical activity (34 studies) [20]* Comprehensive tailoring (6) d=0.13 (0.02-0.24) Limited tailoring (12) d=0.09 (0.02-0.18) No tailoring (16) d=0.16*** (0.11-0.22) Non-sign. interaction			
Theoretical background	*Depression (12 studies) [9]* CBT (12) d=0.42 (0.26-0.59)**** Other (3) d=0.41 (0.27-0.56)**** Non-sign. interaction	*Physical activity (34 studies) [20]* Trans-Theoretical Model Yes (9) d=0.11*** (0.04-0.19) No (25) d=0.15*** (0.10-0.21) Non-sign. interaction	*Physical activity (34 studies) [20]* Social Cognitive Theory Yes (16) d=0.20*** (0.14-0.27) No (18) d=0.09*** (0.03-0.15) Non-sign. interaction	
Updated content	*Physical activity (34 studies) [20]* Updated content Yes (17)d=0.19*** (0.13-0.26) No (17)d= 0.10*** (0.04-0.16) Non-sign. interaction			
Quizzes	*Physical activity (34 studies) [20]* Quizzes Yes (12) d=0.15*** (0.08-0.22) No (22) d=0.14*** (0.08-0.19) Non-sign. interaction			

*p<.10 **p<.05 ***p<.01 ****p<.001 ⌘) No significance reported
Interaction effects are reported as X2; Q; and interaction effect is stated as interaction effect measure is unclear
#) Two meta-analyses [6, 30] calculated the effects of features per outcome, therefore an effect can be shown on one outcome and no effect for other outcome.

Appendix 3: Interaction effect per participant characteristic

Age	*Physical activity (34 studies) [20]* <45 years (19)d=0.13**(0.07-0.18) >44 years (14) d=0.15**(0.09-0.22) Non-sign. interaction	*Weight (23 studies) [6]* <45 (16) WMD=-0.48 (-1.29-0.32) ≥45 (9) WMD=-1.01 (-1.95- -0.07** Non-sign. interaction		

Country of origin	*Weight (23 studies) [6]* Country USA (17) WMD=-0.64 (-1.48-0.19) Other (8) WMD=-0.70 (-1.50-0.09)* Non-sign. interaction			
Gender	*Physical activity (34 studies) [20]* <60% female (12) d=0.10 (0.01-0.19) >59% female (22) d=0.15** (0.10-0.20) Non-sign. interaction	*Weight (23 studies) [6]* <80% female (12) WMD=-0.82 (-1.58- -0.07)** ≥ 80% female (13) WMD=-0.53 (-1.57-0.51) Non-sign. interaction	*Alcohol (16 studies) [34]* Male only (4) g=0.26 (0.12-0.40) **** g=0.20 (0.11-0.28)***** Non-sign. interaction	
Medication	*Depression (18 studies) [29]* Medication allowed Yes (12) g=0.50**** (0.43-0.57) No (2) g=0.15 (-0.05-0.35) Non-sign. interaction			
Population	*Alcohol use (24 studies) [30]* Students (12) WMD=-19.42**** (-29.83—9.00) Non-students (4) WMD=-114.94*** (-198.60- -31.29) Interaction****	*Anxiety (19 studies) [32]* Diagnosed groups (6) d=0.93 (0.66-1.20)[d] Subclinical groups (4) d=0.66 (0.45-0.86)[d] Non-sign. interaction	*Depression (12 studies) [9]* Depression or anxiety (2) d=0.64 (0.24–1.04)*** Only depression (13) d=0.38 (0.25–0.51)**** Non-sign. interaction	*Depression (18 studies) [29]* Diagnosis Yes (7) g=0.37**** No (11) g=0.42**** Non-sign. interaction
Population (continued)	*Depression (19 studies) [33]* Specific population (3) d=0.34**** (-0.54- -0.14) General population (16) d=0.60**** (-0.77- -0.43) X^2=5.09**	*Physical activity (34 studies) [20]* General population (17)d=0.11** (0.06-0.17) Chronic disease (12) d=0.19** (0.11-0.28) Overweight (5) d=0.28** (0.07-0.48) Non-sign. interaction	*Weight (23 studies) [6]* Mean BMI < 30 kg m^{-2} (9) WMD=-1.22 (-1.58- -0.85)**** ≥ 30 kg m^{-2} (16) WMD=-0.61 (-1.46- 0.25) Non-sign. interaction	*Weight (23 studies) [6]* Minimum BMI for determining overweight/obesity < 25 kg m^{-2} (4) WMD=-1.00 (-1.68- -0.31)*** ≥ 25 to < 30 kg m^{-2} (17) WMD=-0.84 (-

				1.57 - -0.10)** 30 kg m^{-2} (3) WMD= -0.18 (-2.25 – 1.88) Not describe d (1) WMD=1 .00 (-0.89 - 2.89) Non-sign. interaction
Population (continued)	*Alcohol use (16 studies) [34]* AT risk drinking (12) g=0.19****(0.09-0.28) Alcohol use disorders identification test (11) g=0.24****(0.12-0.35) Non-sign. interaction			

*p<.10 **p<.05 ***p<.01 ****p<.001 ⌘) No significance reported
Interaction effects are reported as X^2; Q; and interaction effect is stated as interaction effect measure is unclear
#) Two meta-analyses [20,30] calculated the effects of features per outcome, therefore an effect can be shown on one outcome and no effect for other outcome.

Appendix 4: Interaction effects per study feature

Blinding	*Alcohol (16 studies) [34]* Yes (8) g=0.16***(0.04-0.28) No (15) g=0.23****(0.14-0.32) Non-sign. interaction	
Design	*Physical activity (34 studies) [20]* Randomized trial (9) d=0.13*** (0.05-0.21) Randomized controlled trial (25) d=0.16*** (0.09-0.19) Non-sign. interaction	
Publication date	*Weight (11 studies) [7]* Published prior to 1995 (3) WMD: -0.63* (-7.91-6.66) Published 1995 or later (3) WMD: -1.50*** (-2.55- 0.44) X^2=0.05	

Sample size	*Alcohol use (9 studies) [35]* Small <100 (3) g=0.36 (0.19-0.52) ⌘ Large >100 (4) g=0.52 (0.14-0.91) ⌘ Non-sign. interaction	*Physical activity (34 studies) [20]* <35 per group (15)d=0.40*** (0.25-0.55) ≥35 per group (19) d=0.12*** (0.07-0.16) Interaction***	
Type of analysis	*Alcohol use (9 studies) [35]* Type of analysis Intention to treat (3) g=0.37 (0.21-0.54) ⌘ Completers-only (4) g=0.48 (0.11-0.86) ⌘ Non-sign. interaction	*Weight (23 studies) [6]* Use of intention-to-treat analysis No (8) WMD=-0.63 (-1.89- 0.604) Yes (17) WMD=-0.68 (-1.40-0.02)* Non-sign. interaction	*Alcohol use (16 studies) [34]* Intention to treat (13) g=0.22****(0.13-0.31) Completers-only (10) g=0.18 (0.05-0.30)*** Non-sign. interaction
Quality	*Physical activity (34 studies) [20]* Fair (10)d=0.13 (0.02-0.20) Good (24) d=0.15*** (0.10-0.20) Non-sign. interaction		

*p<.10 **p<.05 ***p<.01 ****p<.001 ⌘) No significance reported
Interaction effects are reported as X^2; Q; and interaction effect is stated as interaction effect measure is unclear

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