

Obesity Management

Effectiveness of web-based interventions in achieving weight loss and weight loss maintenance in overweight and obese adults: a systematic review with meta-analysis

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Summary

The objectives of this systematic review are to evaluate the effectiveness of web-based interventions on weight loss and maintenance and identify which components of web-based interventions are associated with greater weight change and low attrition rates. A literature search from 1995 to April 2008 was conducted. Studies were eligible for inclusion if: participants were aged ≥ 18 years with a body mass index ≥ 25 , at least one study arm involved a web-based intervention with the primary aim of weight loss or maintenance, and reported weight-related outcomes. Eighteen studies met the inclusion criteria. Thirteen studies aimed to achieve weight loss, and five focused on weight maintenance. Heterogeneity was evident among the studies with seven research questions examined across interventions of varying intensity. Seven studies were assessed for effectiveness based on percentage weight change, with four studies deemed effective. Although the four meta-analyses suggest meaningful weight change, it is not possible to determine the effectiveness of web-based interventions in achieving weight loss or maintenance due to heterogeneity of designs and thus the small number of comparable studies. Higher usage of website features may be associated with positive weight change, but we do not know what features improve this effect or reduce attrition.

Keywords: Internet, obesity, web, weight loss.

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Introduction

Lifestyle interventions to treat overweight and obesity have been effective in achieving moderate weight loss in the short term. However, currently there is no universally effective approach to weight management that ensures long-term maintenance of lost weight (1,2). Furthermore, cost-effective interventions that are generalizable in real world settings are still required (1). Web-based weight management programmes offer a logical and feasible strategy to treat large numbers of overweight individuals, although to date this medium has been relatively under-utilized and under-evaluated.

Several reviews have explored the effectiveness of web-based and more broadly e-Health interventions, on improving outcomes in the area of weight management, physical activity and dietary intake with equivocal results (3–7). Preliminary studies suggest that web-based interventions may be an effective means to facilitate weight loss (6). Further exploration of web-based interventions on weight management is warranted as it is a research area that is growing rapidly and two of the preceding reviews were limited to studies up until 2006 (4,6). Researchers have highlighted the need to examine which specific elements of web-based interventions enhance the impact on outcome measures, as well as those that increase participation and

reduce attrition rates (5,7). This knowledge will assist in the development of effective interventions that are able to engage and retain large numbers of individuals, potentially enhancing population weight-related health and well-being, which would be of significant public health value.

Therefore, the primary objective is to assess the effectiveness of web-based interventions for weight loss and maintenance of weight loss in overweight and obese adults through use of a systematic review and meta-analysis. Individual interventions were defined as effective if a mean percentage weight loss of greater than or equal to 5% was achieved or maintained, as this is the benchmark for clinically significant weight loss and improvement in weight-related morbidity (8,9). Pooled effectiveness of web-based interventions for weight loss and weight loss maintenance will be determined through meta-analysis. The second objective is to identify which specific components of web-based interventions are associated with greater weight loss and maintenance, as well as low attrition rates.

Methods

This study was conducted using a protocol that was peer reviewed by the Joanna Briggs Institute (JBI). The JBI is an international research organization for evidence-based health care. The protocol can be accessed at: <http://www.joannabriggs.edu.au/protocols/Protocol220.pdf>.

Criteria for study inclusion

Studies were included in the review if they were randomized controlled trials (RCT) with at least one web-based intervention study arm whose primary aim was achieving weight loss or weight loss maintenance. Interventions were considered web-based if participants received information and directly interfaced with the web but they were not required to input information into the website for inclusion. Studies with the aim of achieving positive dietary and physical activity behaviour change with adiposity outcome measures were included. In addition, participants had to be aged 18 years or over with a body mass index greater than or equal to 25. The effects of the interventions were assessed through absolute and/or percentage change in body weight.

Literature search

The search strategy identified both published and unpublished studies in the English language from 1995 onwards. This date was selected, as prior to this web-based interventions and public access to the Internet were uncommon. To identify appropriate keywords, an initial limited search of MEDLINE and CINAHL was undertaken and the title, abstract and index terms used to describe the articles were

undertaken. All identified keywords and index terms were used in the second search of The Cochrane Library, MEDLINE/PREMEDLINE, EMBASE, CINAHL, Web of Science, Scopus PsycINFO, Australian Digital Theses Program, and Dissertation & Abstracts. The reference lists of all retrieved articles were searched for additional studies.

Study selection

All studies identified in the database search were assessed for relevance from the title, abstract and keywords by two independent reviewers. Studies that met all or it was uncertain if they met the inclusion criteria, were retrieved. All retrieved studies were assessed for relevance by two independent reviews. In case of disagreement, a third independent reviewer made the final decision.

Critical appraisal

Included studies were assessed by two independent reviewers for methodological validity using a standardized critical appraisal instrument from the JBI Meta-Analysis of Statistics Assessment and Review Instrument (Appendix I). Any disagreements between the reviewers were resolved by a third independent reviewer.

Data extraction

Data in relation to methodology, intervention effect and compliance with and intensity of the web-based interventions were extracted by the first reviewer using a standardized form developed by the researchers. The form was checked by the second reviewer and a consensus reached where disagreement existed. Authors were contacted if further details were required.

Data synthesis

For each outcome measure, results were described in a narrative summary. Results were pooled in meta-analysis if they were available as either change scores or final values, presented as means with standard deviations, the number of participants was recorded and interventions were similar enough for comparison. Heterogeneity was assessed using chi-squared with significant heterogeneity assigned at a P value < 0.10 . If significant heterogeneity existed, the random effects model was used for statistical analysis; if homogenous, the fixed effect model was used. For continuous outcomes the data from individual studies were combined across studies using either weighted mean difference (WMD) or standardized mean difference (SMD). If the same measurement scales were used WMD was calculated. If varying measurement scales were used that were still considered comparable (e.g. weight and percentage weight

loss), SMD was used. All meta-analyses were conducted using RevMan Analyses 1.0.5 (10).

Results

Description of included studies

Of the 181 articles identified, 20 were included, three were classified as ongoing studies that met all inclusion criteria except having reported intervention effect measures, and 151 were excluded (Fig. 1). Of the 20 articles, 18 different studies were described and study characteristics are outlined in Table 1.

The total number of participants across all studies was 5700, of which at least 77% were female (3.7% unclear). Eleven studies had two intervention arms (11–20), six had three arms (21–26), and one had four intervention arms (27). Thirteen studies had the primary aim of achieving weight loss (11,13,14,16–20,24,26), and five focused on maintenance of weight loss. The length of the intervention period ranged from 6 weeks to 2 years. Eight interventions were 12 months in duration (12–15,17,20–22). Eight interventions ranged from 6 weeks to 6 months (11,16,18,19,23,24,26), one was 2 years (25) and one varied depending on the study arm (27). Only one study

followed up participants beyond the intervention period and this involved follow-up at 3 and 6 months after a 6-week intervention (16). Retention rates varied from 48 to 100% at the post-intervention time point. Eight studies retained greater than 80% of participants (12,17,19,23–26), five retained 60–80% (13,15,18,20–22) and two 40–60% (11,14), one did not provide retention rates for the end of the intervention (16), and one intervention length varied (27). All but one study was conducted in the United States and this was conducted in the UK (14).

Interventions with the primary aim of achieving weight loss explored four distinct research areas. First, web-based programmes compared with a control or minimal intervention group ($n = 3$) (11,14,20). Second, generic web-based programmes compared with enhanced web-based programmes ($n = 5$) (13,16–18,26). This included comparison of a commercial web-based programme with a web-based programme with behavioural therapy ($n = 1$) (13); individually tailored web-based programme with an education only web-based programme ($n = 1$) (16); web-based programme with a web-programme with automated email feedback or human email counselling ($n = 1$) (26) and an education only web-based programme with a web-based programme with education and behavioural therapy ($n = 2$) (17,18). The third group of interventions compared

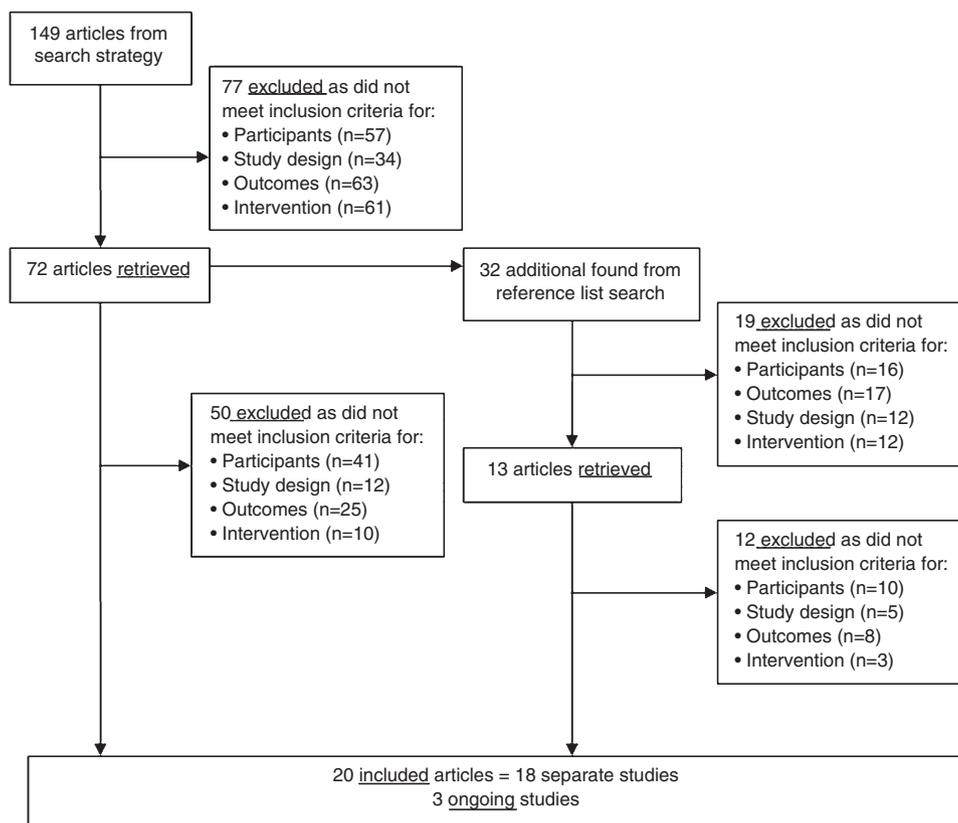


Figure 1 Identifying studies for inclusion.

Table 1 Study characteristics of web-based interventions for weight loss and weight loss maintenance

Study	N	Male : Female	Retention	Setting	Length of intervention	Follow-up	Intervention
Carr <i>et al.</i> 2008 (11)	67	Unclear	48% (32/67)	USA	14 weeks	None	a) WL web (PA only) (n = 37) b) Control (waiting list) (n = 30)
Cussler <i>et al.</i> 2008 (12)	135	0:135	82% (111/135)	USA	12 months	None	a) WLM web (n = 66) b) Usual care control (n = 69)
Gold <i>et al.</i> 2007 (13)	124	23:101	71% (88/124)	USA	12 months	None	a) WL Commercial web-based (n = 62) b) WL Behavioural web-based (n = 62)
Harvey-Berino <i>et al.</i> 2004 (22)	232	38:194	76% (176/232)	USA	12 months	None	a) WLM web-based (n = 77) b) WLM frequent face-to-face (Gp) (n = 77) c) WLM minimal face-to-face (Gp) (n = 78)
Harvey-Berino <i>et al.</i> 2002a (21)	122	18:104	76% (93/122)	USA	12 months	None	a) WLM web-based (n = 40) b) WLM frequent face-to-face (Gp) (n = 41) c) WLM minimal face-to-face (Gp) (n = 41)
Harvey-Berino <i>et al.</i> 2002b (23)	44	Unclear	96% (42/44)	USA	22 weeks	None	a) WLM web-based (n = 15) b) WLM face-to-face (Gp) (n = 14) c) Control: No intervention (n = 15)
McCommon <i>et al.</i> 2007 (14)	221	51:170	59% (131/221)	UK	12 months	None	a) WL web-based (n = 111) b) Usual care control (n = 110)
Micco <i>et al.</i> 2007 (15)	123	21:102	79% (26/123)	USA	12 months	None	a) WL web-based (n = 62) b) WL web-based and face-to-face (Gp) (n = 61)
Mobley 2006 (27)	172	109:63	72% (123/172) at 3 months	USA	3 or 6 months	None	a) WL face-to-face (Gp) and face-to-face (Ind) follow-up (3 months) (n = 43) b) WL face-to-face (Gp) and web-based follow-up (6 months) (n = 43) c) WL face-to-face (Ind) and face-to-face (Ind) follow-up (3 months) (n = 43) d) WL face-to-face (Ind) and web-based follow-up (6 months) (n = 43)
Polzein <i>et al.</i> 2007 (24,29)	58	1:57	86% (50/58)	USA	12 weeks	None	a) WL face-to-face (Ind) (n = 19) b) WL face-to-face (Ind) and web-based (intermittent) (n = 19) c) WL face-to-face (Ind) and web-based (continuous) (n = 19)
Rothert <i>et al.</i> 2006 (16)	2862	487:2375	30% (867/2862) at 3 months 20% (585/2862) at 6 months	USA	6 weeks	3 and 6 months	a) WL web-based individually tailored (n = 1475) b) WL web-based information only (n = 1387)
Svetkey <i>et al.</i> 2008 (25)	1032	382:650	93% (964/1032)	USA	24 months	None	a) WLM self-directed (n = 342) b) WLM web-based (primarily) and phone calls (n = 347) c) WLM phone (primarily) and face-to-face (individual) (n = 342)
Tate <i>et al.</i> 2006 (26)	192	30:162	81% (155/192)	USA	6 months	None	a) WL meal replacements with website (n = 67) b) WL meal replacements with website and automated email feedback (n = 61) c) WL meal replacements with website and human emailing counselling (n = 64)
Tate <i>et al.</i> 2003 (17)	92	9:83	84% (77/92)	USA	12 months	None	a) WL web-based education only (n = 46) b) WL web-based education and behavioural therapy (n = 46)
Tate <i>et al.</i> 2001 (18)	91	10:81	78% (71/91)	USA	6 months	None	a) WL web-based education only (n = 45) b) WL web-based education and behavioural therapy (n = 46)
Webber 2007 (19)	20	0:20	90% (18/20)	USA	8 weeks	None	a) WL web-based with motivational interviewing
a) Pilot study	66	0:66	100% (66/66)		16 weeks	None	b) WL web-based with motivational interviewing and values discussion
b) Final study	47	0:47	66% (31/47)	USA	12 months	None	a) WL web-based with minimal motivational interviewing (n = 33) b) WL web-based with enhanced motivational interviewing (n = 33)
Womble <i>et al.</i> 2004 (20)	47	0:47	66% (31/47)	USA	12 months	None	a) WL web-based (n = 23) b) WL manual (n = 24)

PA, physical activity; WL, weight loss; WLM, weight loss maintenance.

web-based programmes with different types of face-to-face sessions (individual or group), with or without web-based interventions ($n = 3$) (15,24,27). Finally, two studies explored the use of different intensities of motivational interviewing within a web-based programme (19).

Interventions with the primary aim of achieving weight loss maintenance following a standard weight loss programme were also diverse, with three different research questions addressed among them. Web-based programmes were compared with a control or minimal intervention group ($n = 2$) (12,23); face-to-face group sessions ($n = 3$) (21–23); telephone follow-up to a self-directed control group and telephone follow-up with face-to-face individual sessions ($n = 1$) (25).

Quality of included studies

No studies were able to fulfil all requirements for a high-quality study. Three studies were able to meet eight of the 10 requirements (14,17,26). Fourteen of the studies, despite being described as an RCT, did not specify the method of randomization to groups (11–13,15,16,18–24,27). It was therefore also unclear whether those allocating participants to treatment groups were blinded in these studies. The majority conducted an intention-to-treat analysis ($n = 14$) (11–18,20–22,24–27); had comparable groups at entry ($n = 14$) (12–14,16–22,24,26,27); measured outcomes in a reliable manner ($n = 16$) (11–15,17–27) and used appropriate statistical analyses ($n = 17$) (11–22,24–27). All studies measured outcomes consistently for both groups, and treated groups identically, other than the stated intervention.

Effectiveness of web-based interventions aiming to achieve weight loss

The results for total and percentage weight change are described in Table 2. Twelve studies reported total weight change (11,13–15,17–20,24,26,27), while six studies reported percentage weight change (13,16,17,20,24,26). Of the six studies who reported percentage weight change, three were successful in achieving 5% or greater weight change in one or more study arms (13,24,26).

Three studies compared web-based weight loss interventions with minimal interventions or control groups (11,14,20) with differing results. Carr *et al.* and McConnon *et al.* showed no significant difference in weight change between a web-based intervention and a control group (11,14). Alternatively, Womble *et al.* compared a commercially available web-based programme with a weight loss manual, and found significantly greater weight loss among the weight loss manual group at mid- (16 weeks: -0.7 [2.7] vs. -3.0 [3.1], $P = 0.01$) and post-intervention (52 weeks: -0.8 [3.6] vs. -3.3 [4.1], $P = 0.04$) (20). It was unclear

whether two of the studies were effective in achieving a percentage weight change of 5% or more (11,14), while neither the commercially available web-based programme nor the weight loss manual group were defined as effective at mid- (16 weeks: -0.9 [3.2] vs. 3.6 [4.0]) or post-intervention (52 weeks: -1.1 [4.0] vs. -4.0 [5.1]), based on percentage weight change (20). When pooled in a meta-analysis (Fig. 2), the interventions were shown to be significantly heterogeneous ($\chi^2 = 12.84$, d.f. = 2 [$P = 0.002$], $I^2 = 84.4\%$) and there was no significant difference in weight change between the web-based intervention and control groups at post-intervention (SMD 0.73 [–0.06, 1.51] $Z = 1.81$ [$P = 0.07$]).

Five studies (13,16–18,26) compared education only web-based interventions with enhanced web-based programmes. Gold *et al.* reported significantly greater total and percentage weight loss at mid- (6 months: -6.8 kg [7.8], -7.3% [7.8] vs. -3.3 kg [5.8], -3.6% [6.1], $P = 0.005$) and post-intervention (12 months: -5.1 kg [7.1], -5.5% [7.6] vs. 2.6 kg [7.8], -2.8% [5.5], $P = 0.034$) from a web-based programme with behavioural therapy compared with a commercial web-based programme. Therefore the web-based programme with behavioural therapy was deemed effective. The behavioural therapy programme included the addition of individual email feedback on self-monitoring of weight, eating and activity, as well as homework activities. Notably, the commercial programme included prescriptive meal and exercise plans for participants, while the behavioural programme did not (13).

Rothert *et al.* reported significantly greater percentage weight loss at 3 (-0.8% [0.1] vs. -0.4% [0.1], $P < 0.0005$) and 6 months post-intervention (-0.9% [0.1] vs. -0.4% [0.1], $P < 0.0001$) among participants in a 6-week individually tailored web-based programme compared with an information only web-site; however, the intervention is not considered effective due to the percentage weight loss achieved being less than 5% at both time-points. The individually tailored programme included individualized educational material and a weight management plan generated automatically from baseline assessments, as well as a buddy system and the ability to email other participants (16).

Tate *et al.* (2006) demonstrated significantly greater weight loss at post-intervention among participants of a web-based programme with human email counselling compared with a web-based programme alone (-7.0 [5.7] vs. -3.1 [6.0], $P < 0.001$). There was no significant difference in weight loss achieved by a web-based programme with automated counselling when compared with the web-based programme alone or the web-based programme with human email counselling (26). Furthermore, both the web-based programmes with human email counselling and automated counselling achieved a percentage weight

Table 2 Weight-related outcomes for web-based interventions for weight loss and weight loss maintenance

Study	Measurement	Results	Significant difference between groups	Effective*
Weight loss interventions Carr <i>et al.</i> 2008 (11)	Mean weight at 0 and 16 weeks	a) $n = 14$, 0 : 91.1 (5.0) 16 weeks: 90.3 (5.2) b) $n = 18$, 0 : 83.3 (6.6) 16 weeks: 82.9 (6.6)	No	Unclear
	Mean weight change at 6 and 12 months	a) $n = 62$, 6 months: -3.3 (5.8), 12 months: -2.6 (5.3) b) $n = 62$, 6 months: -6.8 (7.8), 12 months: -5.1 (7.1)	Yes: greater loss in group B at 6 and 12 months ($P = 0.005$, 0.034)	Yes: group B at 6 & 12 months
Gold <i>et al.</i> 2007 (13)	Mean percentage weight change at 6 and 12 months	a) $n = 62$, 6 months: -3.6 (6.1) 12 months: -2.8 (5.5) b) $n = 62$, 6 months: -7.3 (7.8), 12 months: -5.5 (7.6)		
	Mean weight change at 6 and 12 months	a) $n = 111$, 6 months: -1.19 (5.1) 12 months: -1.3 (5.6) b) $n = 110$, 6 months: -1 (3.7) 12 months: -1.9 (5.9)	No	Unclear
McConnon <i>et al.</i> 2007 (14)	Mean weight change at 6 and 12 months	a) $n = 62$, 6 months: -6.8 (7.8) 12 months: -5.1 (7.1) b) $n = 61$, 6 months: -5.1 (4.8), 12 months: -3.5 (5.1)	No	Unclear
	Mean weight change at 3 months	a) $n = 43$, -1.04 (0.46) b) $n = 43$, 0.02 (0.46) c) $n = 43$, -0.24 (0.46) d) $n = 43$, -0.90 (0.46)	Yes: greater loss in group A and group D compared with group B and C at 3 months ($P < 0.05$)	Unclear
Polzein <i>et al.</i> 2007 (24,29)	Mean weight change at 12 weeks	a) $n = 19$: -4.1 (2.8) b) $n = 19$: -3.4 (3.4) c) $n = 19$: -6.2 (4.0)	Yes: greater loss in group C compared with group B at 12 weeks ($P = 0.03$)	Yes: group C at 12 weeks
	Mean percentage weight change at 12 weeks	a) $n = 19$: -4.6 (3.2) b) $n = 19$: -3.8 (3.8) c) $n = 19$: -7.1 (4.6)	Yes: greater loss in group C compared with group B at 12 weeks ($P = 0.03$)	
	Mean percentage weight change at 3 and 6 months	a) $n = 1475$ 3 months: -0.8% (0.1), 6 months: -0.9% (0.1) b) $n = 1387$ 3 months: -0.4% (0.1), 6 months: -0.4% (0.1)	Yes: greater loss in group A than group B at 3 and 6 months ($P < 0.0005$ and $P < 0.0001$ respectively)	No
Rothert <i>et al.</i> 2006 (16)	Mean weight change at 3 and 6 months	a) $n = 67$, 3 months: -3.1 (4.0), 6 months: -3.1 (6.0) b) $n = 61$, 3 months: -4.7 (4.3), 6 months: -4.6 (6.1) c) $n = 64$, 3 months: -6.2 (4.2), 6 months: -7.0 (5.7)	Yes: greater loss in group B ($P = 0.005$) and C ($P = 0.001$) compared with group A at 3 months. Greater loss in group C compared with group A at 6 months ($P < 0.001$)	Yes: groups B & C
	Mean percentage weight change at 3 and 6 months	a) $n = 67$, 3 months: -3.3 (3.7), 6 months: -2.8 (5.9) b) $n = 61$, 3 months: -5.8 (4.4), 6 months: -5.3 (6.5) c) $n = 64$, 3 months: -6.8 (3.9), 6 months: -8.1 (6.3)	Unclear	
	Mean weight change at 12 months	a) $n = 46$, -2.0 (5.7) b) $n = 46$, -4.4 (6.2)	Yes: greater loss in group B at 12 months ($P = 0.04$)	No
Tate <i>et al.</i> 2003 (17)	Mean percentage weight change at 12 months	a) $n = 46$, -2.2% b) $n = 46$, -4.8%	Yes: greater loss in group B at 12 months ($P = 0.03$)	
	Mean weight change at 3 and 6 months	a) $n = 45$, 3 months: -1.0 (2.4), 6 months: -1.3 (3.0) b) $n = 46$, 3 months: -3.2 (2.9), 6 months: -2.9 (4.4)	Yes: greater loss in group B at 3 ($P < 0.001$) and 6 months ($P = 0.04$)	Unclear

Table 2 Continued

Study	Measurement	Results	Significant difference between groups	Effective*
Webber 2007a (19)	Mean weight change at 8 weeks	a) $n = 9$, -2.7 (2.9) b) $n = 9$, -1.5 (2.2)	No	Unclear
Webber 2007b (19)	Mean weight change at 16 weeks	a) $n = 33$, -5.22 (4.72) b) $n = 33$, -3.71 (4.46)	No	Unclear
Womble <i>et al.</i> 2004 (20)	Mean weight change at 16 and 52 weeks	a) $n = 23$, 16 weeks: -0.7 (2.7), 52 weeks: 0.8 (3.6) b) $n = 23$, 16 weeks: -3.0 (3.1), 52 weeks: -3.3 (4.1)	Yes: Greater loss in group B at week 16 ($P = 0.01$) and week 52 ($P = 0.04$) Unclear	No
	Mean percentage weight change at 16 and 52 weeks	a) $n = 23$, 16 weeks: -0.9% (3.2), 52 weeks: -1.1% (4.0) b) $n = 23$, 16 weeks: -3.6% (4.0), 52 weeks: 4.0% (5.1)		
Weight loss maintenance interventions				
Cussler <i>et al.</i> 2008 (12)	Mean weight change at 12 months	a) $n = 66$, 0.4 (5.0) b) $n = 69$, 0.6 (4.0)	No	Unclear
Harvey-Berino <i>et al.</i> 2004 (22)	Mean weight change at 12 months (calculated from -6 months)	a) $n = 52$, -4.7 (6.9) b) $n = 61$, -3.9 (5.9) c) $n = 63$, -4.2 (7.9)	No	Yes
	Mean percentage weight change at 12 months (calculated from -6 months)	a) $n = 52$, -8.2% b) $n = 61$, -5.6% c) $n = 63$, -6.0%	No	
Harvey-Berino <i>et al.</i> 2002a (21)	Mean weight change at 12 months (calculated from -6 months)	a) $n = 32$, -5.7 (5.9) b) $n = 30$, -10.4 (6.3) c) $n = 28$, -10.4 (9.3)	Yes: greater loss in groups B & C compared with group A at 12 months ($P = <0.05$)	Unclear
Harvey-Berino <i>et al.</i> 2002b (23)	Mean weight change at 22 weeks (calculated from -15 weeks)	a) $n = ?$, -15.5 (23.4) b) $n = ?$, -19.8 (17.2) c) $n = ?$, -17.3 (15.3)	No	Unclear
Svetkey <i>et al.</i> 2007 (25)	Mean weight change at 24 months (calculated from -5 months and 0)	a) $n = 340$, -5 to 24 months: -2.9 (0.4) 0 to 24 months: 5.5 (0.3) b) $n = 346$, -5 to 24 months: -3.3 (0.4) 0 to 24 months: 5.2 (0.3) c) $n = 340$, -5 to 24 months: -4.2 (0.4) 0 to 24 months: 4.0 (0.3)	Yes: greater loss in group C compared with group A ($P = 0.001$) and group B compared with group C ($P = 0.008$) at 24 months	Unclear

*If $\geq 5\%$ weight change achieved. †Preliminary results at 6 months only included in thesees.
?, sample size unclear.

Review: Effectiveness of Web-based interventions in Achieving Weight Loss and Maintenance in Overweight and Obese Adults: A Systematic Review.
 Comparison: 01 Web-based intervention vs minimal/self directed intervention
 Outcome: 01 Weight change at post-intervention

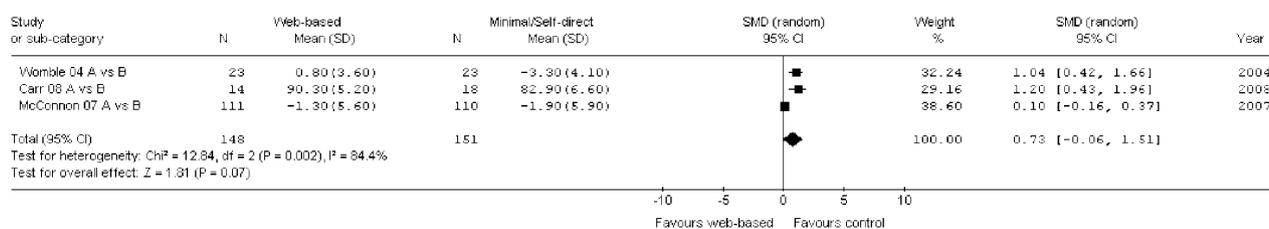


Figure 2 A meta-analysis of three RCTs comparing web-based weight loss interventions with control or minimal interventions.

Review: Effectiveness of Web-based interventions in Achieving Weight Loss and Maintenance in Overweight and Obese Adults: A Systematic Review.
 Comparison: 02 Web-based intervention vs Enhanced Web-based intervention
 Outcome: 01 Weight change at post-intervention

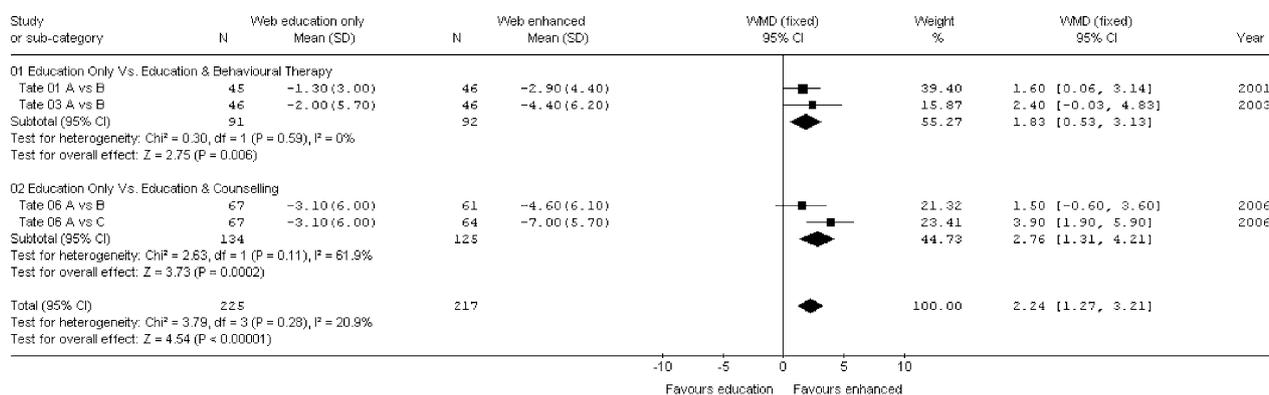


Figure 3 A meta-analysis of three RCTs comparing web-based weight loss interventions with education only with enhanced web-based programmes.

change greater than 5% at mid- and post-intervention. The main difference between the two-enhanced interventions compared with the web-based programme alone was the provision of message boards, a diary to log eating and activity, as well as the feedback on diary entries. Those in the human email counselling group received feedback written individually by a weight loss counsellor based on diary entries, while those in the automated group received automated tailored feedback based on diary entries (26).

Tate *et al.* (2003) and Tate *et al.* (2001) both compared a web-based programme with education to web-based programmes with education and behavioural therapy. Both studies demonstrated significantly greater weight loss and a reduction in waist circumference at post-intervention in the web-based programmes with education and behavioural therapy (17,18). Tate *et al.* (2003) did not report percentage weight change, while Tate *et al.* (2001) reported percentage weight loss less than 5% in both the web-based programme with education and the web-based programme with education and behavioural therapy. The additional behavioural therapy features across both studies were the provision of email feedback from a counsellor based on a participant's self-monitoring of weight, activity and eating

habits, as well as a behavioural weight loss lesson. In Tate *et al.* (2001) the behavioural therapy group also received access to a chat room and email contact with other members, while in 2003 these two features were available to both groups (17,18).

Three studies, corresponding to four study arm comparisons were combined in a meta-analysis (Fig. 3) comparing weight loss at post-intervention in education only web-based interventions vs. those with enhanced features. Studies were grouped by the type of enhanced intervention (behavioural therapy or counselling). Overall, the studies were shown to be homogenous ($\chi^2 = 3.79$, d.f. = 3 [P = 0.28], I² = 20.9%). There was a significant difference in the change in weight between the two groups post-intervention, with a greater decrease in weight in the web-based programmes with enhanced features (WMD 2.24 [1.27, 3.21] Z = 4.54 [P < 0.00001]).

In summary, there are a limited number of studies to assess the effectiveness of web-based interventions in achieving weight loss. Meta-analyses suggest that web-based interventions achieve similar weight loss to control or minimal intervention groups, and web-based interventions with enhanced features achieve greater weight loss than those with education alone.

Effectiveness of web-based interventions aiming to achieve weight loss maintenance

The results for total and percentage weight change are described in Table 2. All weight loss maintenance studies ($n = 5$) reported total weight change. Only one study reported percentage weight change, and it was successful in achieving greater than 5% weight change in two intervention arms (22).

Three studies (12,23,25), with the aim of achieving weight maintenance following a weight loss intervention, compared web-based interventions with minimal interventions or control groups. Two of the three studies were pooled in a meta-analysis comparing weight change after a weight loss maintenance intervention (Fig. 4). The studies were shown to be significantly homogenous ($\chi^2 = 0.02$, d.f. = 1 [$P = 0.90$], $I^2 = 0\%$). There was a significant difference in the change in weight between the two groups post-intervention, with less weight re-gained in the web-based programme (WMD -0.30 [$-0.34, -0.26$] $Z = 13.10$ [$P < 0.000 01$]). The third study showed no significant difference between a web-based intervention and control group in terms of weight change at post-intervention (23). None of the studies reported percentage weight change.

Three weight loss maintenance studies compared web-based with group face-to-face interventions (21–23). Two

of the studies had three arms, with a web-based intervention compared with two intensities of face-to-face interventions (21,22). One study demonstrated significantly better maintenance of weight loss in the two face-to-face groups compared with the web-based intervention, with no significant differences between the two intensities of face-to-face intervention (21). The other study found no significant difference between the three groups, i.e., similar weight loss maintenance in the face-to-face interventions compared with a web-based programme (22). Additionally, they did not demonstrate a percentage weight change of greater than 5% in any of the groups. The difference in intensities of the face-to-face groups ranged from bi-weekly group meetings for 12 months compared with monthly groups meetings for 6 months, and no contact for the remaining 6 months of the intervention (21,22). The two studies were combined in a meta-analysis grouped by intensity of face-to-face intervention (frequent and minimal) (Fig. 5). Overall, the studies were found to be significantly heterogeneous, ($\chi^2 = 12.22$, d.f. = 3 [$P = 0.007$], $I^2 = 77.5\%$). There was no significant difference in the maintenance of weight loss between the groups at post-intervention when comparing face-to-face interventions with web-based interventions (WMD 1.80 [$-1.18, 4.79$] $Z = 1.18$ [$P = 0.24$]). There was also no significant difference in the change in weight between the groups for either frequent or minimal

Review: Effectiveness of Web-based interventions in Achieving Weight Loss and Maintenance in Overweight and Obese Adults: A Systematic Review.
 Comparison: 03 Web-based weight maintenance intervention vs minimal/self-directed intervention
 Outcome: 01 Weight change at post-intervention in a weight-loss maintenance intervention following a weight-loss progra

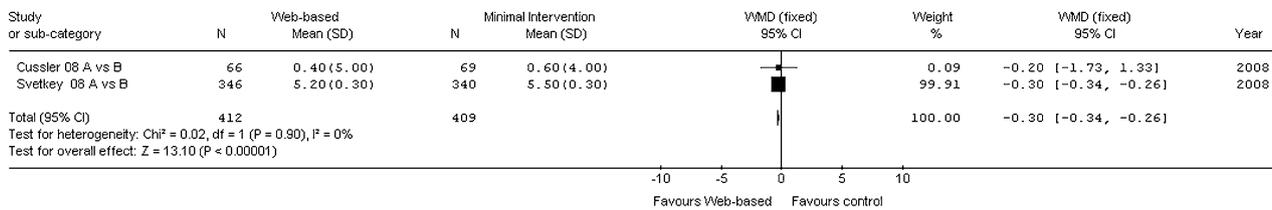


Figure 4 A meta-analysis of two RCTs comparing web-based weight loss maintenance interventions with a control group.

Review: Effectiveness of Web-based interventions in Achieving Weight Loss and Maintenance in Overweight and Obese Adults: A Systematic Review.
 Comparison: 04 Web-based intervention vs face to face intervention
 Outcome: 01 Weight change at post-intervention in a weight-loss maintenance intervention following a weight-loss progra

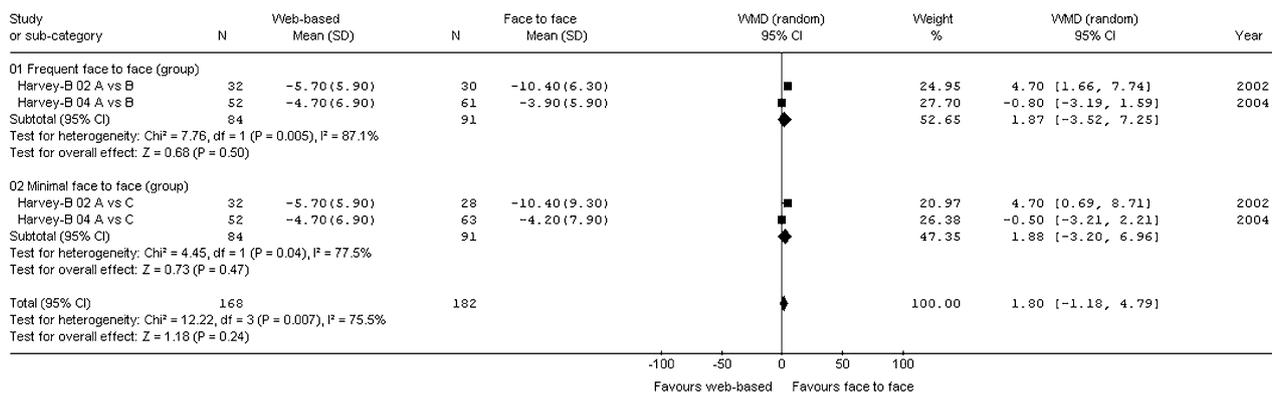


Figure 5 A meta-analysis of two RCTs comparing web-based weight loss maintenance interventions with face-to-face group based interventions.

intensity face-to-face interventions alone. The third study found no significant difference between a web-based intervention and a face-to-face group intervention in terms of weight change at post-intervention (23).

The use of web-based interventions to achieve weight loss maintenance is a largely under-evaluated area. Meta-analyses suggest that web-based interventions achieve similar levels of weight loss maintenance to face-to-face interventions, and less weight is regained in comparison with no intervention.

Components of web-based interventions potentially associated with effectiveness

Sixteen studies explored outcomes related to the usage of the web-based intervention, this included number of log-ins, usage of self-monitoring tools, peer and social support provision, attendance at online chat groups and posts to bulletin boards (Table 3).

Eleven studies tracked web-site usage through log-ins (11,13–15,17–20,25–27). Most studies reported results as mean or median log-ins, making comparisons between studies difficult due to varying intervention lengths. Four studies reported statistically significant differences in number of log-ins between groups (13,17,18,26), three of which demonstrated higher log-ins in a web-based intervention with behavioural therapy (13,17,18). Seven studies investigated associations between weight loss and number of log-ins (13,17–20,26,27), with five studies showing a greater number of log-ins was associated with increased weight loss (13,17–19,26). One study explored associations between number of log-ins and attrition, and found that the initial number of log-ins were significantly lower among those who dropped out by 12 months compared with those that completed the intervention (17).

Ten studies measured participants' usage of self-monitoring tools in the form of online diaries to record weight, food and drinks consumed and/or physical activity undertaken (11–13,19–24,26). Results were not reported in a way that allowed comparisons among studies. Significantly higher levels of self-monitoring were reported in a web-based intervention with behavioural therapy, compared with a commercially available web-based programme (13); web-based intervention with human email counselling compared with a web-based intervention with automated email counselling (26); web-based intervention compared with a face-to-face intervention (22). Five weight loss intervention studies (13,19,20,24,26) and two weight loss maintenance studies (12,22) explored correlations between weight change and level of self-monitoring with six studies reporting a significant correlation between the two (13,19,20,22,24,26). No studies investigated the relationship between attrition and level of self-monitoring.

Four studies explored the level of peer/social support provided, with two measuring perceived social support (13,22), and three the number of peer support contacts (21–23). Gold *et al.* showed higher perceived social support among participants of a web-based intervention that included behavioural therapy compared with a commercially available website (13). Two studies reported a significantly higher number of peer contacts in a web-based only intervention, compared with face-to-face (21,23). No studies investigated associations between the level of social support and weight change or attrition.

Four studies collected data in relation to attendance at online meetings or chat sessions (13,21–23). Three studies demonstrated significantly higher attendance levels in face-to-face groups compared with web-based group (21–23). Gold *et al.* found higher attendance at group meetings in a web-based behavioural therapy programme, compared with a commercially available website. Two studies demonstrated a significant correlation between attendance at group meetings and weight change (13,22). No studies investigated the relationship between attrition and attendance at online meetings or chat sessions.

Two studies looked at number of posts to website bulletin boards (12,19). Webber *et al.* found a greater number of bulletin board posts in a web-based programme with minimal motivational interviewing compared with a web-based intervention with enhanced motivational interviewing. They also demonstrated a positive correlation between the number of posts and increased weight loss (19). No studies investigated the relationship between attrition and posts to website bulletin boards.

Therefore, of the studies that examined the association, most found that the number of log-ins, self-monitoring occasions, chat room attendances or bulletin board posts were associated with greater weight loss or weight maintenance. Only one study explored the association between attrition rates and website usage.

Data were extracted in relation to the features of each web-based intervention for the 24 different web-based interventions described (Table 4). The majority of interventions included generic education material ($n = 22$), a chat room or forum ($n = 16$) and emails ($n = 17$). All but two web-based intervention arms incorporated self-monitoring, of which 13 provided feedback to participants on their self-monitoring of weight, eating and/or activity. Less common features were individualized education material ($n = 3$), and specific diet ($n = 4$) or activity plans ($n = 5$) for participants to follow. The number of features incorporated in the web-based interventions varied from one to 10 features, with seven of the intervention arms having five features, nine had less than five and eight had greater than five. Therefore, due to the diversity of the intervention comparisons within studies, it is difficult to compare the effectiveness of the interventions by intervention intensity.

Table 3 Compliance with web-based intervention components in weight loss and weight loss maintenance studies

Study	Data collected	Results	Significant difference between groups	Correlation with weight change	Correlation with attrition
Overall website usage					
Weight loss interventions					
Carr <i>et al.</i> 2008 (11)	Number of log in days	a) Average of one every 11th day	N/A	NR	NR
Gold <i>et al.</i> 2007 (13)	Median number of log in days at 6 and 12 months	a) <i>n</i> = 62, 0–6 months: 47 (25–65), 6–12 months: 14 (8–23) b) <i>n</i> = 62, 0–6 months: 193 (120–309), 6–12 months: 90 (21–154)	Yes: higher in group B between 0–6 months and 6–12 months (<i>P</i> < 0.001)	Yes: both groups between 0–6 months, but not at 6–12 months (group A <i>P</i> < 0.003; group B <i>P</i> < 0.001)	NR
McCommon <i>et al.</i> 2007 (14)	Mean number of log-ins from 0–12 months*	a) <i>n</i> = 111, 15.8 (15.2)	N/A	NR	NR
Micco <i>et al.</i> 2007 (15)	Mean number of log-ins at 6 and 12 months	a) <i>n</i> = 62, 0–6 months: 223 6–12 months: 99 b) <i>n</i> = 61, 0–6 months: 206, 6–12 months: 90	No	NR	NR
Mobley 2006 (27)	Mean number of log-ins at 3 months	d) <i>n</i> = 43, 17 (30)	NR	No	NR
Tate <i>et al.</i> 2006 (26)	Median number of log-ins at 6 months	a) <i>n</i> = 67, 34. b) <i>n</i> = 61, 20 c) <i>n</i> = 64, 32.5	Yes: groups A and C greater than group B over 6 months (<i>P</i> = 0.03)	Yes: across groups (<i>P</i> = 0.04)	NR
Tate <i>et al.</i> 2003 (17)	Mean number of log-ins at 3, 6, 9 and 12 months	Reported in graph	Yes: higher in group B at 3, 6, 9 and 12 months (<i>P</i> < 0.05)	Yes: groups A & B between 0 and 12 months (group A, <i>P</i> < 0.001, group B <i>P</i> = 0.003)	Yes: number of log-ins at 3 months lower among 12-month drop-outs
Tate <i>et al.</i> 2001 (18)	Mean number of log-ins at 3 and 6 months	a) <i>n</i> = 45, 0–3 months 8.5 (10.4) 3–6 months 1.0 (3.0) b) <i>n</i> = 46, 0–3 months: 19 (10.9), 3–6 months: 6.8 (6.2)	Yes: higher in group B at 3 and 6 months (<i>P</i> < 0.001)	Yes: groups A & B between 0 and 6 months. (group A <i>P</i> = .03; group B <i>P</i> = 0.003)	NR
Webber 2007b (19)	Mean number of log-ins at 16 weeks	a) <i>n</i> = 33, 39.7 b) <i>n</i> = 33, 42.8	No	Yes: groups A & B (<i>P</i> < 0.01)	NR
Womble <i>et al.</i> 2007 (20)	Mean number of log-ins at 12 weeks*	b) <i>n</i> = 23, 17.7 (21.1)	N/A	No	NR
Weight loss maintenance interventions					
Svetkey <i>et al.</i> 2008 (25)	Mean number of log-ins at 30 months	b) <i>n</i> = ? Average log-in once per week and one website contact for 77% of the months	N/A	NR	NR
Self-monitoring					
Weight loss interventions					
Carr <i>et al.</i> 2008 (11)	Completion of online journal activities	a) Average of 13 out of 44 completed	N/A	NR	NR
Gold <i>et al.</i> 2007 (13)	Median number of self-monitored weights at 6 and 12 months	a) <i>n</i> = 62, 0–6 months: 16 (8–22), 6–12 months: 8 (2–13) b) <i>n</i> = 62, 0–6 months: 24 (20–25), 6–12 months: 8 (2–12)	Yes: higher in group B between 0–6 months (<i>P</i> = 0.002) No: between 6–12 months	Yes: both groups between 0–6 months, but not at 6–12 months (group A <i>P</i> < 0.001; group B <i>P</i> < 0.001)	NR
Polzein <i>et al.</i> 2007 (24,29)	Mean number of meals logged at 12 weeks	b) <i>n</i> = 19, 261.4 (128.6) c) <i>n</i> = 18, 53.9 (39.8)	No	Yes: groups B and C <i>P</i> < 0.01	NR
	Mean number of diaries with kcal logged at 12 weeks	a) <i>n</i> = 19, 6.5 (3.8) b) <i>n</i> = 19, 3.5 (3.1)	No	Yes: group B (<i>P</i> < 0.001)	NR
	Mean number of diaries with exercise logged at 12 weeks	a) <i>n</i> = 19, 7.2 (3.7) b) <i>n</i> = 19, 3.9 (3.1)	No	Yes: group B (<i>P</i> < 0.001)	NR
Tate <i>et al.</i> 2006 (26)	Mean number of weeks diary submitted at 6 months	b) <i>n</i> = 61, 11.4 (9.2) c) <i>n</i> = 64, 17.2 (8.7)	Yes: group C greater than group B (<i>P</i> = 0.000)	Yes: groups B & C (<i>P</i> < 0.001)	NR
Webber 2007b (19)	Mean number of diaries completed per week at 16 weeks	a) <i>n</i> = 33, 9.1 b) <i>n</i> = 33, 7.5	No	Yes: groups A & B (<i>P</i> < 0.01)	NR

Table 3 Continued

Study	Data collected	Results	Significant difference between groups	Correlation with weight change	Correlation with attrition
Womble <i>et al.</i> 2004 (20)	Mean number of days diary completed at 52 weeks	a) <i>n</i> = 24, 29.0 (35.3) b) <i>n</i> = 23, 18.3 (21.7)	No	Yes: across groups week 16 ($P < 0.01$) and 52 ($P < 0.006$)	NR
Weight loss maintenance interventions					
Cussler <i>et al.</i> 2008 (12)	Mean number of times diet logged at 12 months	a) <i>n</i> = 66, 53.4 (62.3)	N/A	No	NR
	Mean number of weights logged at 12 months	a) <i>n</i> = 66, 26.9 (19.9)	N/A	No	NR
	Mean number of times physical activity logged at 12 months	a) <i>n</i> = 66, 67.5 (76.3)	N/A	No	NR
Harvey-Berino <i>et al.</i> 2004 (22)	Mean number of diaries submitted at 12 months	a) <i>n</i> = 77, 18.6 (13.2) b) <i>n</i> = 77, 11.6 (13.2)	Yes: higher number in group A ($P < 0.01$)	Yes: both groups ($P < 0.01$)	NR
Harvey-Berino <i>et al.</i> 2002a (21)	Proportion of possible records diaries submitted at 12 months	a) <i>n</i> = 40, 19% b) <i>n</i> = 41, 22%	No	NR	NR
Harvey-Berino <i>et al.</i> 2002b (23)	Proportion of possible records diaries submitted at 12 months	a) <i>n</i> = ? 38% (29) b) <i>n</i> = ? 45% (31)	No	NR	NR
Social support					
Weight loss interventions					
Gold <i>et al.</i> 2007 (13)	Perceived Social Support Scale at 6 and 12 months	a) <i>n</i> = 62, 6 months: 3.5 (2.9), 12 months: 2.8 (2.9) b) <i>n</i> = 62, 6 months: 6.7 (3.2), 12 months: 7.6 (2.7)	Yes: higher for group B at 6 and 12 months ($P < 0.001$)	NR	NR
Weight loss maintenance interventions					
Harvey-Berino <i>et al.</i> 2004 (22)	Perceived Social Support Scale at 6 and 12 months	NR	No	NR	NR
	Mean number of peer contacts at 12 months	a) <i>n</i> = 77, 27.1 (58.2) b) <i>n</i> = 77, 4.9 (17.4)	Yes: higher in group A ($P < 0.01$)	NR	NR
Harvey-Berino <i>et al.</i> 2002a (21)	Mean number of peer contacts at 12 months	a) <i>n</i> = 40, 6.8 (13.5) b) <i>n</i> = 41, 0.04 (0.43)	Yes: higher in group A ($P = 0.02$)	NR	NR
Harvey-Berino <i>et al.</i> 2002b (23)	Mean number of peer contacts at 22 weeks	a) <i>n</i> = ? 4 (4) b) <i>n</i> = ? 15 (28)	No	NR	NR
Attendance at online meetings/chat sessions					
Weight loss interventions					
Gold <i>et al.</i> 2007 (13)	Median number of facilitated meetings attended at 6 and 12 months	a) <i>n</i> = 62, 0–6 months: 1 (0–3), 6–12 months: 0 (0–0) b) <i>n</i> = 62, 0–6 months: 21 (19–23), 6–12 months: 11 (6–14)	Yes: higher number in group B between 0–6 months and 6–12 months ($P < 0.001$)	Yes: group B only between 0–6 months ($P < 0.001$)	NR
Weight loss maintenance interventions					
Harvey-Berino <i>et al.</i> 2004 (22)	Mean number of group meetings/chat sessions attended at 12 months	a) <i>n</i> = 77, 10 (5.1) b) <i>n</i> = 77, 7.7 (5.3)	Yes: higher attendance in group B ($P = 0.02$)	Yes: both groups ($P < 0.01$)	NR
Harvey-Berino <i>et al.</i> 2002a (21)	Proportion of possible group meetings/chat sessions attended at 12 months	a) <i>n</i> = 40, 39% b) <i>n</i> = 41, 54%	Yes: higher in group B ($P = 0.04$)	NR	NR
Bulletin boards/forums					
Weight loss interventions					
Webber 2007b (19)	Mean number of posts at 16 weeks	a) <i>n</i> = 33, 7.2 b) <i>n</i> = 33, 2.4	Yes: greater number in group A ($P = 0.03$)	Yes: groups A & B (group A $P < 0.05$, group B $P = 0.068$)	NR
Weight loss maintenance interventions					
Cussler <i>et al.</i> 2008 (12)	Mean number of posts at 12 months	a) <i>n</i> = 66, 12.9 (19.7)	N/A	No	NR

N/A: not applicable; NR: not reported.
?, sample size unclear.

Table 4 Web-based intervention features

Study	Group	General info	Individualized info	Goal setting	Self-monitoring (feedback)	Self-monitoring (no feedback)	PA plan	Diet plan	Chat room	Online meeting	Professional email	Buddy	Email	Total no. of features
Weight loss interventions														
Carr <i>et al.</i> 2008 (11)	A	✓	X	✓	✓	X	✓	X	X	X	X	✓	X	5
Gold <i>et al.</i> 2007 (13)	A	✓	X	✓	X	✓	✓	✓	✓	✓	X	✓	✓	9
	B	✓	X	✓	X	✓	X	X	✓	✓	✓	X	X	6
McConnon <i>et al.</i> 2007 (14)	A	✓	✓	✓	X	✓	X	X	X	X	X	X	✓	5
Micco <i>et al.</i> 2007 (15)	A B	✓	X	✓	X	✓	✓	✓	✓	✓	✓	X	✓	9
Mobley 2006 (27)	C D	✓	X	✓	X	✓	X	X	X	X	X	X	✓	4
Polzein <i>et al.</i> 2007 (24,29)	B C	X	X	X	✓	✓	X	X	X	X	X	X	X	1
Rothert <i>et al.</i> 2006 (16)	A	✓	✓	X	X	X	✓	✓	X	X	X	✓	✓	6
	B	✓	X	X	X	X	X	X	X	X	X	X	X	1
Tate <i>et al.</i> 2006 (26)	A	✓	X	X	✓	X	X	X	X	X	X	✓	✓	4
	B	✓	X	X	X	✓	X	X	✓	X	X	✓	✓	5
	C	✓	✓	X	✓	✓	X	✓	✓	X	✓	✓	✓	7
Tate <i>et al.</i> 2003 (17)	A	✓	X	X	✓	X	X	X	X	X	✓	X	✓	4
	B	✓	X	X	X	✓	X	X	X	X	✓	X	✓	5
Tate <i>et al.</i> 2001 (18)	A	✓	X	X	✓	X	X	X	X	X	✓	X	✓	2
	B	✓	X	X	X	✓	X	X	X	X	✓	X	✓	5
Webber 2007 (19)	A	✓	X	X	✓	X	X	X	✓	X	X	X	X	3
	B	✓	X	X	✓	X	X	X	✓	X	X	X	X	4
Womble <i>et al.</i> 2004 (20)	A	✓	X	✓	✓	X	✓	✓	✓	✓	X	✓	✓	9
Weight loss maintenance interventions														
Cussler <i>et al.</i> 2008 (12)	A	✓	X	X	✓	X	X	X	✓	X	X	X	✓	4
Harvey-Berino <i>et al.</i> 2004 (22)	A	✓	X	X	X	✓	X	X	✓	✓	✓	X	✓	6
Harvey-Berino <i>et al.</i> 2002a (21)	A	✓	X	X	X	✓	X	X	✓	✓	✓	X	✓	6
Harvey-Berino <i>et al.</i> 2002b (23)	A	X	X	X	✓	✓	X	X	✓	✓	✓	X	✓	5
Svetkey <i>et al.</i> 2008 (25)	B	✓	X	✓	✓	X	X	X	✓	X	X	X	✓	5
Total per feature		22	3	8	9	13	5	4	16	8	8	7	17	

✓ Includes feature X Does not include feature.
 General info: generic information/education/lessons; Individualized info: individualized information/education/lessons; Goal setting: setting of weight loss related goals; Self-monitoring (no feedback): tool to monitor weight; diet and physical activity provided; Self-monitoring (feedback): tool to monitor weight, diet and physical activity provided, if completed feedback provided; PA plan: physical activity plan or prescription (e.g. energy expenditure target, ideas for exercise); Diet plan: diet plan or prescription (e.g. calorie target, menu plans); Chat room: chat room, forums or bulletin boards; Online meeting: professionally facilitated online meetings; Professional email: ability to contact health professional via email; Buddy system: linking members to other members with similar goals; Email: ability to email other members.

Each of the meta-analyses previously explored included two or three studies. Thus, a sub-group analysis exploring differences in weight change based on intervention intensity is not feasible.

Discussion

This systematic review develops the evidence base in the area of web-based interventions for weight loss and weight loss maintenance. An additional 12 studies are included here, which were not part of the previous review by Saperstein *et al.* that included just six studies (4). Five of the additional studies are included due to the addition of weight loss maintenance interventions in this review, while seven have been published since 2006. These findings demonstrate the increased research interest and activity in the area, with the number of research articles more than doubling in less than 2 years.

Overall, of the seven studies (13,16,17,20,22,24,26) with percentage weight change data available, only four studies could be defined as effective (13,22,24,26). The majority of studies did not report percentage weight change. Therefore, we cannot determine the true number of effective web-based interventions. We also cannot conclude absolutely that there is no difference in weight loss between web-based and control groups due to the heterogeneity identified in the meta-analysis. Despite demonstrating significantly greater weight change in web-based weight loss maintenance interventions compared with controls further research is required as only two studies were included in the meta-analysis. Furthermore, the meta-analysis results also suggest that web-based interventions achieve similar weight loss maintenance to face-to-face programmes, but due to heterogeneity of studies this is not conclusive.

Saperstein *et al.* concluded that a critical component of web-based weight loss programmes is the personalization achieved through feedback or tailored information (4). The meta-analysis suggests that web-based weight loss interventions with enhanced behavioural features such as counselling and individualized feedback are more effective at achieving weight loss at post-intervention than web-based programmes with education alone. However, despite the homogeneity of these results only three studies were included in the analysis, all of which were from the same research groups, which questions the external validity of the analysis. No studies were identified that explored the effect of enhanced web-based interventions on weight loss maintenance; therefore research is also warranted in this area.

The overall quality of included studies was moderate; with study design potentially impacting on effectiveness. To improve the quality and reporting of studies we suggest future studies consult the CONSORT statement (28).

Recent RCTs of behavioural weight loss programmes are on average 31.4 weeks in length, follow-up participants for 41.8 weeks and have 28 participants, of which 21.2% drop-out (2). The average intervention length for the studies in this review was 37.5 weeks. However, the intervention length of four studies (11,16,19,24) was less than the standard behavioural treatment intervention length of 16 weeks (2). Furthermore, the long-term impact of web-based programmes remains unknown due to the lack of follow-up beyond the intervention. The mean number of participants across studies was 316.7, with only one study including a small number of participants ($n = 20$) (19). Retention rates within the intervention period were less than 80% for many interventions ($n = 9$) (11,13,14,16,18,20–22,27). Moreover, two of the three ineffective studies had retention rates less than 60% (18,22), suggesting that the high attrition rates has impacted the ability of the studies to detect change. Therefore, it is recommended that future RCTs explore strategies to improve retention rates, ensure interventions are of an appropriate length and follow-up participants for at least 1 year post intervention to increase the likelihood of detecting weight and behaviour change.

A key component of eHealth interventions, such as web-based programmes, is ensuring ample use of the technology (both frequency and duration) so each participant receives an 'optimal dose' (3). The review demonstrates that the number of log-ins, self-monitoring occasions, chat room attendances and bulletin board posts were associated with greater weight loss or weight loss maintenance in most, but not all, studies that have examined this association. There are also some findings to suggest that lower initial intervention usage is associated with attrition. However, most studies reported findings as an average number of contacts with a particular feature, therefore not allowing comparability between studies, and making it difficult for the reader to ascertain compliance with the intervention over time. Furthermore, the studies were not designed to determine the impact of each feature on weight loss or weight loss maintenance, so these associations are not cause-and-effect. Therefore, future RCTs or longitudinal studies should report usage as a proportion of possible or expected contacts with the particular web-feature and aim to ascertain the ultimate dose required to achieve satisfactory weight loss or maintenance, while maintaining adequate attrition rates.

The review demonstrates the diversity in the number and type of components featured in web-based interventions. This highlights the need for succinct research questions and detailed intervention descriptions to allow readers to truly understand the components of the interventions being compared. It also highlights the importance of interpreting the meta-analysis results with caution due to this additional potential source of heterogeneity.

The definition of 'effectiveness' is limited as it does not take into consideration other key indicators of success such as waist circumference or percentage body fat. However, given the low number of studies that reported percentage weight change, it is unlikely that a definition utilizing body composition would be more robust. This highlights the need for a consistent definition of effective weight loss and weight loss maintenance to be adopted by researchers. Such a definition would allow for greater comparability between studies and meta-analysis of results.

Conclusion

Implications for practice

Web-based weight loss and weight loss maintenance interventions have the potential to achieve outcomes similar to other lifestyle treatment options. However, while there is emerging evidence of effectiveness, we cannot currently recommend which components of web-based interventions are essential to enhancing weight loss within treatment for overweight and obesity.

Implications for researchers

The evidence in relation to the effectiveness of web-based interventions in achieving weight loss and weight loss maintenance remains uncertain, but is more convincing than in previous reviews. Future research in the area should prioritize well-designed efficacy trials comparing web-based interventions with the traditional methods of delivering lifestyle interventions (e.g. individual and group-based counselling) or to waiting list controls. In addition, studies should be designed to determine which components of web-based interventions are critical to achieving efficacious weight loss and/or weight loss maintenance, including determination of an optimal usage or intervention dose. To ensure high-quality research in the area, strategies to improve retention rates and engagement with the web-based intervention (e.g. through email reminders, telephone prompts or via enhanced programme features) should be further explored. In order to facilitate future systematic reviews and meta-analyses of programme effectiveness all studies should report participants mean percentage weight change. Finally, to address the gap in long-term follow-up of participants' studies need to report results up to at least 1 year post intervention and ideally longer.

Conflict of Interest Statement

Clare Collins is the consultant dietitian and Penelope Jones is the research dietitian for SP Health Co. who produces a web-based weight management programme.

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Appendix I Critical Appraisal Instrument

1. Was the assignment to treatment group truly random?
2. Were participants blinded to treatment allocation?
3. Was allocation to treatment groups concealed from the allocator?
4. Were the outcomes of people who withdrew described and included in the analysis?
5. Were those assessing outcomes blind to treatment allocation?
6. Were the control and treatment groups comparable at entry?
7. Were groups treated identically other than the named intervention?
8. Were outcomes measured in the same way for all groups?
9. Were outcomes measured in a reliable way?
10. Was appropriate statistical analysis used?

Yes, No or Unclear response for each question.

Source: JBI Meta-Analysis of Statistics Assessment and Review Instrument (<http://www.joannabriggs.edu.au/services/sumari.php>)