

The effect of web-based technology on weight loss maintenance

- A systematic literature review

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Abstract

Title: The effect of web-based technology on weight loss maintenance - a systematic literature review

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Introduction: Achieving weight loss is possible, however, weight regain is the most common long-term outcome. Self-monitoring - behavioral awareness - is associated with successful weight loss maintenance, as well as adherence. Modern technology might lessen the burden of self-monitoring and thus enhance adherence. To date, few long-term studies have evaluated the effect of web-based technology on weight loss maintenance.

Objective: The aim of this systematic review is to evaluate the evidence whether web-based technology is beneficial for weight loss maintenance.

Search Strategy: The literature search was carried out in the databases PubMed, Scopus and Cochrane. Free-text search words of relevance for the research question were used.

Selection Criteria: Studies included were randomized controlled trials on humans, written in English, with weight as primary outcome measure. Participants were adults who had lost >4 kg, with the exception of weight loss achieved by surgery and/or medication. Studies published prior to 2005 were excluded, as well as studies shorter than 18 months.

Data collection and analysis: Two articles that matched our inclusion criteria were identified and quality assessed by each author individually, using the Swedish Council on Health Technology Assessment (SBU) evaluation template. The combined strength of evidence for the two articles was set using the GRADE system.

Main results: Two studies filling the search criteria were identified, both high in quality. In total 1346 overweight or obese subjects, who had lost 4 kg, or 10% of their bodyweight before entry into the study, were followed for 18 months. Web-based technology was modestly trending toward a positive effect on weight loss maintenance, but the results displayed serious heterogeneity between studies (moderate evidence, +++). Web-based technology and personal contact had similar effects on weight maintenance, but the data suffered from low precision (moderate evidence, +++).

Conclusions: Behavioral strategies such as self-monitoring are strongly associated with a positive outcome on long-term weight loss maintenance. We are looking for means that facilitate the translation of theory into practice.

Key words: "weight maintenance", "self weighing", "self-monitoring", "prevent regain", "internet", "technology"

Sammanfattning

Titel: Effekten av internetbaserade hjälpmedel vid bibehållande av viktnedgång - en systematisk litteraturöversikt

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Bakgrundsproblem: Övervikt och fetma ökar risken för hjärt- och kärlsjukdomar och bidrar till höga samhällskostnader. Viktnedgång är möjligt men bibehållande av den nya vikten är problematiskt. Följsamhet och självmonitorering - medvetenhet kring det egna beteendet - är associerat med lyckat bibehållande. Den tekniska utvecklingen av bland annat smartphones kan potentiellt underlätta självmonitorering och förbättra följsamhet. Det finns begränsat vetenskapligt underlag gällande webbaserad teknologi och bibehållande av viktnedgång.

Syfte: Syftet med denna systematiska översiktsartikel är att undersöka huruvida webbaserad teknologi främjar bibehållande av viktnedgång.

Sökväg: Litteratursökningen gjordes i databaserna PubMed, Scopus och Cochraine. Fria sökord med relevans för frågeställningen användes.

Urvalskriterier: Vi inkluderade randomiserade kontrollerade humanstudier, med vikt som primärt utfallsmått. Studiedeltagarna, vuxna människor >19 år, skulle ha åstadkommit en viktnedgång på minst 4 kg genom valfri metod, dock ej på kirurgisk väg eller med hjälp av orlistat. Studier publicerade före 2005 exkluderades, liksom studier kortare än 18 månader.

Datainsamling och analys: Två artiklar som uppfyllde inklusionskriterierna identifierades och granskades av två av varandra oberoende författare. En mall från Statens Beredning för medicinsk Utvärdering användes. Den sammanvägda evidensstyrkan från de två artiklarna bedömdes enligt GRADE-systemet.

Resultat: Två artiklar som uppfyllde inklusionskriterierna identifierades, båda av hög kvalitet. Totalt 1346 deltagare med övervikt eller fetma som före randomisering gått ner minst 4 kg eller 10 % av sin kroppsvikt, följdes under 18 månader. Internetbaserade hjälpmedel visar en blygsam trend mot en positiv effekt för bibehållande av viktnedgång jämfört med kontrollgruppen, dock visade resultaten heterogenitet (måttlig evidens, + + +) att internetbaserade hjälpmedel inte har någon effekt på bibehållande av viktnedgång i jämförelse med personlig kontakt, men datan hade låg precision (måttlig evidens, + + +).

Slutsats: Beteendemodifierande metoder så som självmonitorering är starkt förknippat med ett lyckat bibehållande av viktnedgång. Vi letar efter fungerande metoder att översätta teori till praktik.

Nyckelord: "bibehållande", "viktuppgång", "självmonitorering", "viktnedgång", "internet", "teknologi"

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Introduction

“Globesity”

The problem of overweight and obesity is affecting 1,9 billion adults worldwide. The WHO estimates that every year 2,8 million people die as a result of being overweight or obese, and the prevalence has nearly doubled in the last 35 years. Historically obesity has been more common in high-income countries, but is today a rapidly growing problem in low and middle income countries as well (1). Overweight and obesity is associated with an increased risk of cardiovascular disease (CVD) and a lower quality of life (2). In Sweden 1 million people are overweight or obese, adding up to a cost of at least 3 billion SEK a year, and, even more if you include the indirect secondary costs such as paid sick leave, early retirement and decreased productivity. Over nutrition and obesity can be considered a costly burden, adding up to 2 percent of the Swedish health care systems total costs (2).

The U-turn pattern

Weight loss can be achieved in a number of different ways. To obtain 5–10% weight loss of initial body weight can substantially diminish risk factors of CVD. However, alarmingly few individuals are able to maintain their weight loss over time, and weight regain remains the most common long-term outcome. Even the most successful weight losers regain an abundant amount of weight within the first couple of years (3). With the exception of weight loss achieved through bariatric surgery, similar patterns regarding weight change outcomes have been described in past intervention studies. As these studies indicate, weight loss typically peaks at around six months, followed by gradual regain of weight, shaping the weight curve into a U-turn pattern. There are numerous different diets that are designed for weight loss and to some extent for weight maintenance. In Sweden the SBU recommendations are a diet low fat, a diet low carbohydrate or a diet high in proteins (2). The high protein and low-glycemic-index diet can possibly be beneficial for body weight and body composition according to the Diogenes study; a study where diets different in protein and glycemic index content was consumed ad libitum (4).

Keeping the weight off

The positive effects of weight loss are interdependent with keeping the weight off, which is crucial if we are to decrease health-care related costs associated with overweight and obesity, as well as lowering CVD risk factors (5). To identify methods to avoid regain in weight is therefore of equal interest as achieving initial weight loss. Weight loss maintenance is a great challenge from many different perspectives. Studies have been carried out within the fields of integrative physiology, genetics, endocrinology, and behavioral and cognitive sciences. Factors associated with low success rates is the inability to consolidate new habits which can lead to behavioral fatigue, as well as physiological compensation for reduced weight. Weight loss and negative energy balance is regulated through a highly complicated feedback system between the brain and the periphery. This leads to increased appetite and disproportionately decreased energy expenditure, thus creating the optimal circumstance for weight regain (6). Still it is not clear to what extent each of these factors contribute. However, the main reason behind failing weight loss maintenance has been identified as declining adherence to the weight loss strategies over time (5) and more than one study draws the conclusion that being able to change both eating and physical activity habits is necessary, and a key component to a successful long term weight maintenance. One strategy that has been identified as associated with successful weight loss as well as weight loss maintenance and long-term adherence, is combined self-monitoring and ongoing contact with the health-care services. Self-monitoring

involves making weight-losers aware of their behavior and to pay adequate attention to their own actions, usually by keeping food diaries and records of physical activity (7). The National Weight Control Registry (NWCR) has screened for behaviors among successful weight maintainers and found that eating a diet low in fat, frequent self-monitoring of body weight and food intake, and high levels of regular physical activity are behavioral strategies strongly associated with a positive outcome. The NWCR states that, if an individual is able to keep the lost weight off for 2-5 years, the chances of long-term success increase greatly. To be able to draw conclusions from a weight loss maintenance study, the trial must be long. The NIH Working Group Report suggests that 12-24 months is an appropriate length, based on the fact that time is of great importance (6).

Frequent monitoring of weight allows one to detect weight regain in its early stages and to initiate strategies to reverse the trend and avoid a major relapse (5). What is considered as a successful weight loss maintenance? There is more than one answer to this question and no consensus to be found. The NWCR suggests a 10% achieved and maintained weight loss (3). In The STOP Regain study weight gain less than 2,3 kg was considered successful (8). Even if weight gain occurs an individual can be considered successful if the person is weighing approximately 10% below initial weight. This will still have an impact on improved overall health (5). A systematic review has compiled the most common ways to describe successful weight loss maintenance. Weight loss in the 5–9% range of initial body weight contributes to important health benefits and is used by the Food and Drug Administration in evaluating weight loss medications. Other studies indicate that weight loss $\geq 10\%$ of initial body weight produces greater health benefits. Furthermore, a recent analysis of Diabetes Prevention Program lifestyle intervention data showed that weight loss reduced the risk of diabetes even at weight loss as low as 2% of body weight (9).

Health related technology

The widespread utilization of the internet and the rapid speed of technological advancements has created opportunities within the field of communication and interaction. Internet access and smartphones makes it possible to reach a larger group of patients in an easier and more cost effective way, and might lessen the burden of self-monitoring and thus enhance adherence (3, 7, 10). The potential to use this kind of technology to deliver personalized interventions and expand the reach within clinics and health care still lies ahead. With new web based technologies, the possibility to affect research and clinical outcomes in weight loss maintenance has emerged (6). According to SKL, Swedish municipality and county councils, the digitalization has the possibilities to promote equal health- and welfare, and together with the Swedish government a so called e-health vision was developed and founded in 2016. The e-health vision wants to optimize personalized health care by making patients involved in their own treatments to a further extent. Informed patients are increasingly able to make individual decisions and are thus more independent, which is favorable for both patients and the health-care system (11). Digital Health and eHealth (electronic health) are words used to describe technology that encompass devices or software applications in which information is collected, stored, manipulated, and/or transmitted using the binary system (12).

This study investigates whether current advances in technology may be helpful for increasing adherence to self-monitoring. The most commonly used method to self-monitor diet is the paper diary which can be both time consuming and tedious to complete and makes instant feedback unfeasible (13). The current more widespread access to computer-based technology for use in self-monitoring has resulted in a new generation of studies (7). In Sweden, 90 % of the population has access to a computer with an internet connection and recent statistics show

73% owns a smartphone (14). Few clinical trials lasting longer than 12 months have evaluated the effect of web-based technology, and to date no one has conducted an examination of this literature. This article provides a systematic review of clinical trials evaluating the effect of web-based technology on weight loss maintenance.

Problem

The difficulty of maintaining weight loss continues to be a problem that needs to be resolved, as weight regain eliminates the positive effects of weight loss such as decreased CVD risk factors. Understanding how best to support people in sustaining weight loss is paramount, as it is crucial to uphold health benefits. Compared with the many suggestions of how to initiate weight loss, there are still few studies that have identified a working strategy for maintenance. There are, to date, no systematic reviews available that examines the effects web based technology for prevention of weight regain.

Aim

The aim of this systematic literature review is to evaluate the evidence whether web-based technology is beneficial for weight loss maintenance compared with minimal intervention in overweight or obese adult men and women.

Research question

Does web-based technology, compared with personal contact and minimal intervention, have a greater effect on weight loss maintenance in adult overweight or obese individuals?

Methods

This systematic review was conducted according to the SBU recommendations (15), covering 2 randomized controlled trials. The 2 articles were quality assessed and the strength of evidence was assessed using GRADE. This review focuses on publications reporting weight change from randomization to end of trial comparing the difference between web-based technology compared to a control group and personal contact

Inclusion and exclusion criteria

Type of studies - Studies included were randomized controlled trials with one web-based technology group. We excluded studies published prior to 2005 as well as non-human studies.

Type of participants - Participants were adults (aged >19, no upper age limit) who had actively lost >4 kg prior to the intervention phase. We excluded studies that recruited participants who had lost weight through the effects of illness or disease, bariatric surgery, liposuction and/or orlistat, or suffered from any kind of eating disorder.

Type of interventions - Personal contact and web-based technology weight maintenance interventions with a minimum of 18 months were included. Primary outcome measure - The included outcome measure was weight (e.g. absolute weight change from start of maintenance phase to end of trial).

Table 1. Literature search

Search	Database	Date	Search word, free search	Limitations	Matching articles (duplicates)	Selected articles	Reference to selected articles
1	PubMed	January 25 to February 4, 2016	self-monitoring weight maintenance	Clinical trial, published before 2005 and adults 19+ years	26	1	Wing, Tate et al. 2006
			weight maintenance interactive		12 (4)		
			self-weighing weight maintenance		7 (4)		
			self-monitoring prevent weight regain		3 (2)		
			weight self-monitoring internet		36 (4)		
			weight self-monitoring digital		11 (2)		
			Long term weight maintenance interne		9		
			long term weight maintenance regain		26 (4)		
			weight maintenance web based technology		3 (3)		
			weight maintenance modern technology		0		
			prevent weight regain self-monitoring		3 (3)		

			long term weight maintenance regain		26 (26)		
			weight maintenance online		9		
			interactive self- monitoring weight		16 (8)		
			web technology weight maintenance		3 (2)		
			face-to-face weight maintenance		20 (6)		
			weight maintenance personal contact		4 (3)		
2	Scopus	February 6, 2016	"self- monitoring" AND "weight maintenance"	limit to article, language English	89 (38)		
			"self- monitoring" AND "prevent weight regain"		6 (3)		
			interactive self- monitoring weight		46 (19)		
			face-to-face weight maintenance		38 (28)		
			"weight maintenance" AND "personal contact"		8 (4)		
			"web technology" AND "weight maintenance"		13 (5)		

Search Strategies

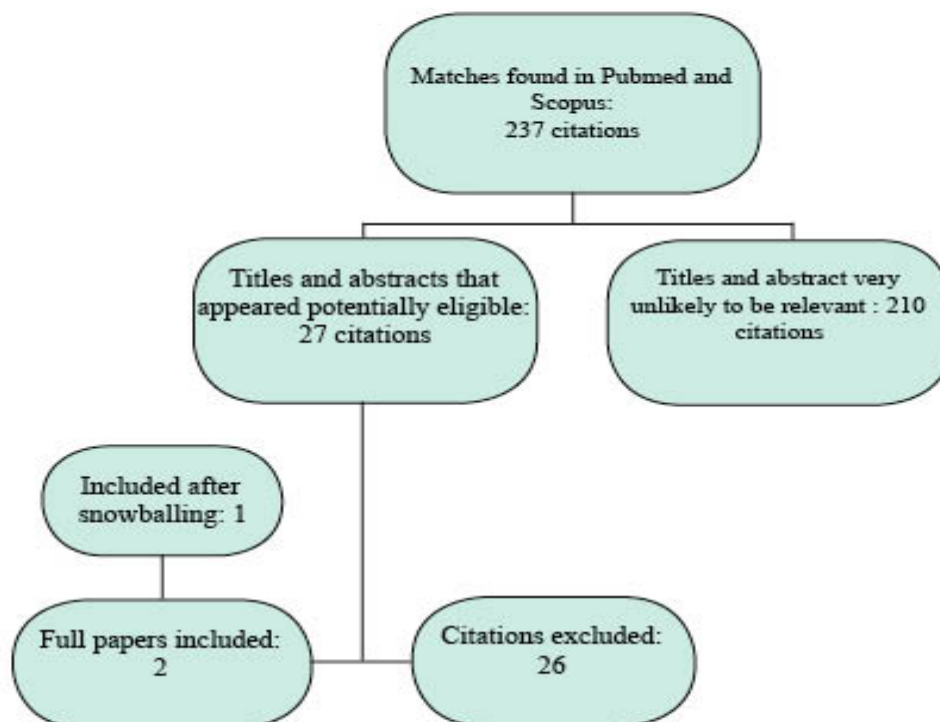
Time frame for search: January 25th 2016 - February 6th 2016. The search was conducted in PubMed and Scopus. An additional search was performed in the Cochrane Database of Systematic Reviews revealed that no systematic reviews were made in the area covered by our search question. Furthermore, we applied the snowball method to all references of relevant studies. A test search was performed in order to explore terms in titles and abstracts commonly used in this field of study.

Key words included was “weight maintenance”, “self-weighing”, “self-monitoring”, “prevent regain” and “technology”. Search limiters included randomized controlled trials (RCT), humans and adults (age ≥ 19 years) and no studies published before 2005. The MESH and search terms are clarified in Appendix 1, the included and excluded studies are listed in Appendix 2.

Selection of articles

Titles and abstracts from PubMed and Scopus was screened and the two authors performed eligibility assessment and selected screened records independently in an un-blinded, standardized manner. Disagreements between the authors were resolved by consensus. To summarize the study selection processes, an adapted flow chart diagram was used.

Figure 1. Flow chart



Study selection

In the search, 237 articles were found and 27 were selected; 11 were excluded because they focused on weight loss and not maintenance, 4 were not RCT, 5 did not meet our research question, 2 were based on the same study as selected article 1 (5), one did not include our outcome measure, and one did not meet the inclusion criteria of 18 months. By searching the reference sections of the eligible studies, other relevant articles were identified and one more paper meeting our inclusion criteria emerged (16). In summary, 2 articles were selected. The results are based on 2 randomized controlled trials.

Data collection, and analyses

Processing of data

The quality of evidence was assessed for both identified articles, using The Swedish Council on Health Technology Assessment (SBU) evaluation template for RCTs. At first by each author individually, and in the next step a consensus was reached. The quality assessment evaluates the risk of selection bias, performance bias, detection bias, attrition bias, reporting bias and other considerations such as conflicts of interest, resulting in a combined score for each article: low, moderate or high risk of bias. The included articles are presented individually in table 2.

To summarize the strength of the scientific evidence for an individual outcome measure, the GRADE system was applied. GRADE is an acronym for “the Grading of Recommendations Assessment, Development and Evaluation”. A template provided by Gothenburg University were used. Grading the quality of evidence and the scientific strength of the outcome measures is rated in to different categories; high (+++), moderate (+++), low (++) and very low (+). Outcome measure was evaluated in both articles at 18 months. The evidence is summarized in the evidence table 3.

Results

Fig. 1 represents the study selection process. The search strategy identified 401 citations. Following duplicate removal, we were left with 237 citations. After title and abstract screening, we judged 27 articles as potentially eligible. We excluded 26 articles for the presence of one or more exclusion criteria, one article was selected (8). One article (16) was found by the snowball effect, searching the reference sections of the eligible studies. Therefore, we used data from 2 RCTs, illustrating the effect of web-based technology on weight maintenance. Both studies were conducted in The United States.

Description of studies

The included articles are presented individually in text and subsequently summarized in Table 2. A compiled judgment of the strength of evidence can be found under “Evidence summary” in Table 3.

Table 2.

Author Year Reference Country Founding source ClinicalTrial.gov	Study design Follow-up time	Population (N/drop-outs)	Interventions Control Exposure	Effects
Svetkey et al. 2008 (16) National Heart, Lung, Blood Institute ClinicalTrial.gov Identifier: NCT00054925	RCT 30 months (only data at 18 months were included)	Overweight and obese men and women who had lost at least 4-kg prior to intervention (1032/68)	Intervention: I1: Web-based technology I2: Personal contact C: Self-directed with minimum introduction	Weight gain I1: 3,8 kg I2: 3,1 kg
Wing et al. 2006 (8) National Institute of Diabetes and Digestive and Kidney Diseases ClinicalTrial.gov Identifier: NCT00067145	RCT 18 months	Overweight and obese men and women who lost at least 10 % of their bodyweight during the 2 years prior to the intervention. (314/23)	Intervention: I1: Web-based technology I2: Personal contact C: Self-directed with minimum introduction and quarterly newsletter	Weight change I1: 4,7 ± 8,6 kg I2: 2,5 ± 6,7 kg C: 4,9 ± 6,5 kg

Study 1: A Self-Regulation Program for Maintenance of Weight Loss (8)

The aim of the STOP Regain study was to evaluate the possibility of preventing weight regain by comparing a face-to-face program and an internet program to a newsletter control group. Weight gain at 18 months was the primary end point of the study.

The study personnel recruited participants who during the prior two years had lost at least 10% of their initial body weight, a clinically important amount of weight. A sample size of n=314 enabled a statistical power of 80% to detect a 3-kg difference between groups.

Participants were randomized to one of three groups of the study, and no significant differences in baseline data were detected. The main focus of the intervention groups was teaching participants self-regulation of body weight, with no difference in content and frequency of contact. The initial month of the trial included weekly meetings for the intervention groups, whilst the remaining part of the trial consisted of monthly meetings. Participants in the control group were only seen at the clinic for assessments and had no further contact with the intervention staff. They received a quarterly newsletter containing information regarding diet, exercise and weight control.

By the final assessment at 18 months, mean (\pm SD) absolute weight gain was 2.5 \pm 6.7 kg in the face-to-face group as compared with 4.7 \pm 8.6 kg in the Internet group and 4.9 \pm 6.5 kg in the control group. There was a significant difference in weight gain between the face-to-face and control groups (absolute difference, 2.4 kg; 95% confidence interval, 0.002 to 10.8; P = 0.05), but not between the face-to-face group and the Internet group (2.2 kg; 95% CI, -0.50 to 10.3; P = 0.09), or between the Internet group and the control group (absolute difference, 0.2 kg; 95% CI, - 4.9 to 5.9; P = 1.00). 93% of participants (n = 291) completed the 18-months follow-up. The percentage of participants that consistently remained below a 2.3 kg weight gain was 37.5% in the Internet group and 43.8% in the face-to-face group, compared to 22.9% of those in the control group; both intervention groups showing a significant difference compared to the control group. The study findings indicate that face-to-face is a more successful approach to weight maintenance.

Quality assessment: The study quality was rated as high (low risk of bias). The risk of selection bias was considered low due to an adequate randomization method and -process. The nature of the study limits the possibility of blinding participant and personnel, but the design of the study is considered to be the more robust approach to long-term weight control and do not increase the risk of performance bias. The only remark made was on detection bias considering there was no blinding of outcome assessment, therefore the risk of detection bias was judged to be moderate.

Study 2: Comparison of Strategies for Sustaining Weight Loss - The Weight Loss Maintenance Randomized Controlled Trial (16)

The study objective was to compare an interactive technology-based intervention and a personal-contact intervention to one and other and with a self-directed control group. This 30 months long multicenter Weight Loss Maintenance study (WLM) randomized 1032 participants to one of the 3 arms, where primary criterion was weight loss of at least 4 kg prior to randomization. The personal contact intervention included monthly individual contact with an interventionist, whereas in the interactive technology-based intervention group participants were encouraged to regularly log on to an interactive web site. Setup in the 2 intervention groups were identical regarding dietary and physical activity recommendations. Participants in the control group received lifestyle guidelines with diet and physical activity recommendations. No significant differences in baseline data between the three groups were detected.

Participants were randomized to phase 2 (maintenance phase) if a weight loss of at least 4 kg was achieved during phase 1, a 6-month weight loss program. Participants enrolled in phase 1 was overweight or obese adult men and women with a body mass index (BMI) of 25-45.

Primary outcome was weight change at 30 months from randomization, and the number of recruited participants provided 90% power to detect a 2.0-kg difference in weight change between either of the interventions vs the control group.

At 18 months there was a 3,1 kg weight regain in the personal contact intervention group and a 3,8 kg weight regain in the technology based group. Weight regain continued to be significantly less in the technology based group than in the self-directed group through 24 months of follow-up.

By the final assessment at 30 months, mean weight regain was 4.0 kg in the personal contact group as compared with 5.2 kg in the interactive technology-based group and 5.5 kg in the self-directed control group. Those in the personal-contact group regained 1.5 kg less weight than those in the self-directed group (95% CI, 2.4-0.6 kg; P=.001), whereas those in the interactive technology based group regained only 0.3 kg less than those in the self-directed group (95% CI, 1.2-0.6 kg; P=.51). Those in the personal-contact group regained a mean of 1.2 kg less than those in the interactive technology based group (95% CI, 2.1-0.3 kg; P=.008). The percentage of participants that consistently maintained at least a 4 kg weight loss was 40.8% in the interactive technology group and 45.2% in the personal contact group, compared to 39.5% of those in the control group; only showing a significant difference between the personal contact group and the self-directed. Each major data collection visit was completed by 93-96% of the participants. The study findings indicates that personal contact is moderately successful in sustaining weight loss, whereas an interactive technology based intervention shows early success but decreases over time.

Quality assessment: The study quality was rated as high (low risk of bias). The risk of selection bias was considered low due to an adequate randomization method and process. The nature of the study makes blinding of participants and personnel inapplicable, but the design of the study is considered to be the more robust approach to long-term weight control and thus do not increase the risk of bias. Adherence decreased over time in the intervention groups, however not sufficiently to increase the risk of performance bias.

Grading of evidence

The GRADE analysis of the outcome measure weight change at 18 months is presented in Table 3. The aggregated strength of evidence was determined in each comparison:

Web-based technology vs. control group, moderate (+ + +)

No limitations were found regarding internal validity, external validity, precision or publication bias. Serious limitations were found regarding heterogeneity, and thus strength of evidence is graded moderate. The basis for downgrading homogeneity are the results found at 18 months, where the WLM study shows a significant difference (absolute difference, -1,1 kg; P = 0.003) and Wing et al shows no significant difference (absolute difference, 0.2 kg; 95% CI, -4.9 to 5.9; P = 1.00).

Web-based technology vs. personal contact, moderate (+ + +)

No limitations were found regarding internal validity, external validity or publication bias. Serious limitations were found regarding precision, hence strength of evidence is graded moderate. The basis for downgrading precision are the lack of power in the STOP Regain study.

Table 3. Evidence summary

	Web-based technology vs. control group	Web-based technology vs. personal contact
Outcome measure	Weight change	Weight change
Number of studies	2	2
Study limitations	RCT (+ + + +)	RCT (+ + + +)
Risk of bias	No limitations	No limitations
Homogeneity	Serious limitations (-1)	No limitations
Study population - external validity	No limitations	No limitations
Precision	No limitations	Serious limitations (-1)
Publication bias	No limitations	No limitations
Strength of evidence	Moderate (+ + +)	Moderate (+ + +)

Discussion

The aim of this systematic review was to analyze the literature on the effect of web-based technology on weight loss maintenance. The literature search identified 2 randomized controlled trials, from here on referred to as the WLM study and the STOP Regain study.

There seems to be a general pessimism on the subject of weight loss maintenance. Large efforts are spent on weight loss, but if almost no one succeeds with long-term maintenance, is it really worth it? We feel the need to clarify that the answer still is yes. Even if weight regain occurs, lifestyle changes and new habits can contribute to health effects and decrease the risks associated with overweight and obesity (5). It is of great concern to find working strategies that enhance adherence, which promotes lifestyle changes and thus increase maintenance.

Our study findings suggest that web-based technology is modestly trending toward a positive effect. Both studies were trending towards a positive effect, but only in the WLM study the effect was significant. This was also the reason why the strength of evidence was lowered from high to moderate. The heterogeneous results of web-based technology warrant a closer look at the exact differences between the programs in the 2 studies. As a matter of fact, they might differ so much that they should be regarded as two totally different treatments. Hence, the digitalization could still perhaps be of use in the maintenance programs, either as a complement or an alternative way to behavioral treatment programs with personal contact. With internet access a large amount of individuals can be reached, and this could be beneficial when health care resources do not match the growing demand. We are in no way suggesting technology as a replacement for personal contact. However, in a maintenance condition - where adherence and monitoring is of great importance - we could take advantage of the web-based technology qualities. Maybe a combined treatment with day to day feedback delivered by a smartphone and weekly or monthly sessions with a registered dietitian could be a conceivable solution. It may also be helpful for health care personnel to tailor treatment and provide feedback in close proximity to the performance.

Another possible area of use for web-based technology is measurement of adherence. To date, the methods are limited and needs further exploration. As we see it, the exact frequency of self-monitoring that makes a difference in weight outcomes may be easier to examine with the help of web-based technology and in particular smartphones. Further studies are needed to determine if this could contribute to pinpoint the amount of self-monitoring needed to be successful. Technologies such as wireless scales and ecological momentary assessments (EMA) can contribute both to measure adherence and the delivery of feedback. This can create an opportunity to document the process of weight regain, regarding the attitudinal, behavioral, and physiological changes that precede regain. In the long run this may be a way to deliver support when most needed. Smartphones could, compared to a computer-based website, be more easy-accessed and provide instant feedback to a further extent. Professionals yes, and more so society are responsible of creating opportunities for people to be, and to feel, autonomous and thus facilitate long-term behavior change. Tools and services provided by web-based technology, as a part of the e-health care, has a need to be of an accurate design to promote motivation and facilitate self-monitoring and adherence.

The relevance of our conclusions for the Swedish health care system was graded as high. Personal contact is already applied within the Swedish health care system during weight loss treatment. However, both studies were performed in the US and in the WLM study 38% of the participants were African Americans. This makes us question the applicability of these results to the Swedish population and thus the evidence grading "moderate" could have been more just. Participants in weight studies are generally dominated by women. This was obvious in The STOP Regain study where 80% were women whereas the WLM study sought to enroll 40% men. Worldwide, the problem of overweight and obesity is more common among women than men. However, in Sweden there are more overweight men than women, and in obesity there is no difference between the genders. Self-monitoring behaviors are affected by gender and ethnicity. Studies show that men are more adherent than women (7). Could new technologies increase the adherence regardless of gender or ethnicity? In other areas the anonymity and solidarity that web based communication can offer have contributed to enabling the aged, the disabled, and the discriminated (17). Maybe the anonymity of web based technologies can be equally as empowering in weight loss maintenance.

The world is moving from agrarian to urban at a faster pace than ever before, and large regions in Sweden are sparsely populated. The distance to health care can be remote. People who don't live in inner cities shouldn't be forced to commute. Instead, they should be able to receive maintenance treatment at home via web-based technology; as a complement or an alternative to existing treatment programs. This might contribute to more people leaving the car at home, which from a sustainability perspective would be favorable.

In the WLM study, the dietary and physical activity recommendations were identical in both intervention groups, and in both interventions features associated with maintenance of behavior change were incorporated. In the STOP Regain study the personal contact and web-based technology interventions were identical in frequency of contact and content, with difference in how they submitted their measures and received feedback. How come the results between the two studies differ when the interventions are identical as far as content is concerned? As we see it, perhaps using mean absolute weight change as primary outcome is misleading the results. When looking at the results from the web-based technology intervention from another perspective, the positive tendency appears to be more clear - of the 314 participants in the study, 37.5 % of those in the web-based technology group regained

less than 2.3 kg compared to 22.9% of those in the control group. Then, there is the question of power which sheds a different light on the outcomes. The sample size in the STOP Regain study was selected to provide a statistical power of 80% to detect a 3 kg difference between groups whereas in the WLM study, sample size was designed to provide 90% power to detect a 2.0-kg difference. In the STOP Regain study the difference between web-based technology and personal contact was 2.2 kg ($P= 0.09$). Could a sample size to detect a 2 kg difference have made this result significant, keeping in mind that maintenance trials must include a large number of subjects to detect modest effects (6). Hence, the results regarding web-based technology from our study are ambiguous and difficult to interpret. With the current advances within the field of web-based technology, the results from our study might appear to be a slightly bit out of date. Our reviewed studies dates back to 2006 and 2008 and web-based technology has changed since.

From our literature search, the RCT Improving Weight Maintenance Using Virtual Reality 'Second Life' (18) was rejected due to not meeting our selection criteria on length. In this weight loss maintenance study, 20 overweight and obese individuals were randomized to either a web-based technology group or a personal contact and web-based technology group. Contrary to our study, the results from Second Life showed significantly greater weight maintenance in the web-based technology group compared to the personal contact group. In this study from 2013, the interventions are based on more modern technology. Could this be a contributing factor to the more positive result compared to our review?

Self-monitoring and adherence is a corner-stone in the weight loss maintenance treatment, and the health care system is facing strain and needs new possible solutions to handle this growing population with lifestyle diseases. There is a need for more studies that are ranging over a longer period of time, at least 24 months. This to evaluate what success factors contributes to keeping weight off for a longer period of time, and to explore if a substantial period of maintenance is contributing to a long term weight reduction. It is with suspense we await the result from The NULevel trial (19), an RCT where a technology assisted weight loss maintenance intervention is compared to a minimum contact control group.

The strongest point of our review is that the included studies are RCTs of high quality. In both studies adherence decreased over time, and attendance was consistently better in the personal contact groups than in the web-based technology groups. In the WLM study, participants remained engaged in the web site throughout 24 months, which was associated with the maintaining of weight loss. Both studies have the same methodological weaknesses in line with other diet and exercise interventions; the impossibility of blinding the participants. The WLM study had blinded their evaluation staff but not the STOP Regain study, which contributed to a slightly lower quality. None of the studies found it problematic that they themselves designed the study, took sole responsibility for treating participants and collecting and analyzing the data. This was something we questioned in regard to conflict of interest but this design is considered to be the more robust approach, hence no remarks were made.

Conclusion

Behavioral strategies such as self-monitoring are strongly associated with a positive outcome on long-term weight loss maintenance. We are looking for means that facilitate the translation of theory into practice. Our study findings suggest that web-based technology is modestly trending toward a positive effect on weight loss maintenance.

”Never a dull moment”

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