Social support and its influence on online weight loss interventions: A systematic review

Sina Kindler

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First supervisor: Dr. S. M. Kelders

Second supervisor: Dr. E. de Kleine

University of Twente

Positive Psychology and Technology

Abstract

Background: Overweight is a growing problem in our modern-day society. Almost half of the Dutch population is categorized as overweight. Online weight loss interventions are implemented on the internet to counter or to prevent this problem. The purpose of designing these interventions is that they persuade people to change their everyday behaviour to successfully lose weight. Different factors have been found to be essential, one of which is social support. Giving participants the opportunity to exchange their experiences and to learn from each other can increase the effectiveness of an online intervention. Moreover, it is relevant in what way(s) social support is implemented, because there seem to be important differences with regard to the effectiveness of an intervention.

Objective: The aim of this review is to examine how social support is implemented within online interventions and linking that to the effectiveness of online weight loss interventions.

Methods: To categorize social support, this review will make use of two different approaches: a categorization of Morrison, Yardley, Powell, and Michie (2012) and the Persuasive System Design model (PSD-Model). This review focuses on weight loss interventions by looking at the selection criteria, which also describe the effect for the outcome weight loss and the persuasive elements. For the data extraction, the interventions were analysed using the following categories: study characteristics, groups, study design, opportunities for social interaction, forms of social support, persuasive technology in the technology, and the effectiveness of these interventions. The effect size for the differences between pre- and post-test per intervention were presented as Cohen's d.

Results: The final search yielded 9 articles, but for the final analyses 14 interventions were used, because some articles described two different online interventions. All 14 interventions provide at least one feature for social support. The most frequently used form was asynchronous-mediated intervention with peers, implemented in the form of discussion forums. Furthermore, the number of PSD elements of social support ranges between 2 and 6 elements in the interventions. Almost all interventions report a positive outcome for weight loss. It is indicated that asynchronous-mediated contact with peers is positively associated with weight loss, as well as simulation of person-to-person interaction, using avatars. The PSD elements "Normative influence", "Recognition" and "Competition" and "Cooperation" indicate a positive association with the effectiveness of an online intervention.

Discussion: This review supports earlier findings that online weight loss interventions offer a good way for participants to lose weight. Furthermore, social support seems to be an effective way of encouraging the participants to stay actively involved in the process of behaviour change and therefore losing weight through learning from others. It has also been shown that much more research is necessary to get insight into the "Black Box". A way to do that would be to do research on what motivates participants to use social support features and how they use this, because the results also indicate a positive association between usage of the social support features and weight loss.

Samenvatting:

Achtergrond: Overgewicht vormt een steeds groter maatschappelijk probleem. Bijna de helft van de Nederlandse bevolking heeft overgewicht. Om overgewicht terug te dringen, zijn er online interventies ontworpen. Het doel van dergelijke interventies is om mensen te stimuleren om hun alledaagse gedrag te veranderen. Verschillende factoren blijken hierin een belangrijke rol te spelen, waaronder sociale steun. Er is gebleken dat het uitwisselen van ervaringen en het kunnen leren van elkaar bijdraagt aan de effectiviteit van online interventies. Er is echter ook aangetoond dat de manier waarop sociale steun geïmplementeerd wordt, het effect van een online interventie kan beperken door anonieme en grote groepen. Om sociale steun te categoriseren maakt deze review gebruik van de categorisatie van Morrison et al. (2012) en het Persuasieve System Design Model (PSD-Model).

Doel: Het doel van dit onderzoek is om na te gaan hoe sociale steun in online interventies geïmplementeerd wordt en in hoeverre verschillende elementen van sociale steun bijdragen aan de effectiviteit van online interventies.

Methode: Deze review is onderdeel van een grotere studie, waarin de relatie tussen technologie en eHealth interventies is onderzocht. Daarnaast richt dit onderzoek zich op online interventies die zich richten op gewichtsvermindering en gebruik maken van persuasieve elementen. In de data-analyse zijn de volgende categorieën meegenomen: studie karakteristieken, groepen, studie design, mogelijkheden voor sociale interactie, vormen van sociale steun, PSD elementen en effectiviteit. Om de effectsize te bepalen is Cohen's d berekend.

Resultaten: Negen artikelen kwamen overeen met de inclusiecriteria. In een aantal artikelen werden twee verschillende online interventies beschreven. In totaal zijn er 14 interventies geanalyseerd. In elke interventie werd minimaal een feature voor sociale steun gebruikt. De meest gebruikte feature was asynchronous-mediated communicatie met andere deelnemers, voornamelijk in de vorm van een discussie forum. Het aantal PSD elementen varieerde tussen twee en zes elementen in de interventies. Bijna alle interventies bleken effectief te zijn in gewichtsreductie. Dit duidt op een positief verband tussen asynchronous-mediated communicatie en de effectiviteit van een interventie. Ook de PSD elementen ''Normatieve invloed'', ''Recognitie'', "Competentie" en "Coöperatie" laten een positief verband zien met gewichtsreductie in een online interventie.

Discussie: Deze review ondersteunt eerder onderzoek waaruit bleek dat online interventies een belangrijke bijdrage kunnen leveren om overgewicht terug te dringen. Het is ook aangetoond dat sociale steun een belangrijke rol speelt in het motiveren van mensen om gewicht te verliezen en dat er veel geleerd kan worden van anderen. De resultaten laten tevens zien dat er meer onderzoek nodig is om meer inzicht te krijgen in de factoren die bepalen of de participanten een interventie gebruiken en de manieren waarop zij de interventies gebruiken. De gevonden resultaten laten een positief verband zien tussen gebruik van de features voor sociale steun en gewichtsverlies.

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Introduction

Over one billion people worldwide are overweight, a number which has doubled since 1980 (WHO, 2015). In the Netherlands more than 48,3 % of the population are categorized as overweight or obese (Gezondheidsmonitor GGD CBS RIVM, 2012). Health issues, like type 2 diabetes, high blood pressure, degenerative joint disease, and cardiovascular disease are among the possible consequences. Besides that, mental problems like anxiety or depression (Statistics Netherlands, 2014) are possible psychological consequences.

This review will discuss one possible way of dealing with the problem of being overweight, namely online weight loss interventions, especially the role and the influence of social support provided in these interventions. Before weight loss interventions were implemented online, various offline interventions have been introduced to help people change their behaviour and lose weight (Verheijden, Bakx, van Weel, Koelen, & van Staveren, 2005). The most important components for such offline interventions are: diet, physical activity and social support through educational and counselling sessions via one-on-one contact with a caregiver or group meetings (Franz et al., 2007; Jeffery, Wing, Sherwood, & Tate, 2003; Schlicht & Haglund, 2015). Especially the role of social support has gained a lot of attention, because sharing the same goal and the same experiences seems to motivate people to reach their goal (van Dam et al., 2005).

Although the Social Learning Theory of Bandura (1977), later called Social Cognitive Theory (SCT), was introduced long before weight loss interventions have been implemented and examined, it can also provide a possible explanation for the effects social support can have on weight loss today. The theory states that we learn by observing other people's behaviour, attitude, or outcome of that behaviour. The people we observe are called models. Everyone is surrounded by models in their daily lives, such as parents, friends, peers at school, workmates, but also people in the media. We simply learn by observing their behaviour, without even being consciously aware of it. Therefore, different mechanisms play an important role. Firstly, we focus our attention during observational learning and we are more likely to focus our attention on people that we perceive as similar to us. Secondly, we build up mental images of the behaviour, what is called retention. Furthermore, while observing others performing target behaviour and storing it, we are able to reproduce it later if needed (reproduction). Finally, observing others enhances the motivation to perform and adhere to that behaviour. This is determined by the reinforcement we get through the target behaviour, so if we regard this as positive we are more likely to perform the same behaviour. As such, all of our behaviour is determined by a reciprocal interaction between cognitive, behavioural and environmental factors and influences. Being surrounded by people in an offline weight loss intervention who share the same goal and seeing them lose weight can lead to a higher motivation to perform the same behaviour. This is why the Social Learning Theory can provide good insights into why social support plays such an important role in offline and, as will be seen later, in online intervention. An example of

how social support is provided in offline weight loss intervention based on the principles of the Social Learning Theory is shown in Springfield et al. (2015). They describe an offline intervention for African-American women. Group sessions take place twice a week, each session lasting about 90 minutes during which the woman first has the chance to describe her experiences, receive information about eating healthily, followed by 45 minutes of physical activity. It was particularly important that, besides increasing self-efficacy, self-regulation and observational capability, the groups were led by other African-American women (observational learning = modelling) who show successful weight changing behaviour. This is a good example of how social support works in an offline weight loss intervention. Implementing weight loss intervention on the Internet required new ways of providing social support as well, because no personal contact takes place. This review tries to answer the question of how social support is implemented online through examining different studies, and showing how this is related to the effectiveness of online intervention. Similar to the example of Springfield et al. (2015), this review will only focus on the support people receive from others participating in the intervention.

Although offline weight loss interventions show good results with regard to weight loss, providing these interventions online can bring a lot of advantages, such as a higher capacity of participants in these interventions (Krukowski, West, & Harvey-Berino, 2009; Verheijden et al., 2005) and, in the long run, online interventions are less expensive and less resource-taxing than face-to-face support (Cussler et al., 2008). Another important advantage compared to offline interventions is that people have direct access to these interventions and can get help immediately when needed, because often there are no waiting lists (Cuijpers, van Straten, & Andersson, 2008). Wantland, Portillo, Holzemer, Slaughter, and McGhee (2004) also mention that researches can provide more data, such as number of visits to web pages and time spent on it. This is useful to determine which elements on websites are most beneficial for the effectiveness with regard to weight loss, and which elements do not provide more effective online weight loss over time. The results of this research already revealed that the features that work in offline interventions, such as diet, physical activity and social support, are also effective tools in online interventions and can be achieved by providing educational information about healthy eating, diaries in which participants can report the daily food and exercises, but also through discussion forums or chats to support social learning. Also, other research has shown that social support also plays an important role on the internet (Gorin et al., 2005; Morrison et al., 2012; Wing & Jeffery, 1999). In a paper of Hwang et al. (2010) participants of an online weight loss intervention expressed that besides exchanging social support in the form of encouragement and motivation, information and shared experience, which is similar to face-to-face support, participants appreciate the aspects of convenience, anonymity, and non-judgmental interaction as unique advantages of online interventions. Furthermore, the participants reported that social support helps them cope with being overweight and with losing extra weight.

Kim and Shyam Sundar (2014) show how important it is to effectively implement social support on the Internet. Anonymity and a large number of participants are possible reasons why online interventions fail in motivating for behaviour change and therefore for weight loss, because participants feel less engaged and committed to the intervention. This is described by the Social Impact Theory (SIT). This theory describes the influence of group dynamics, which, in short, means that people's behaviour is affected by the number of people around them. Specifically, it describes the "bystander effect", which states that an individual will feel less responsible when surrounded by many other people. If no other people are around who can also be held responsible, most people are more willing to help those in need. In many online interventions, social support is provided through, for example, discussion forums, where all participants can post or read the comments of others. This can result in participants not using these features, because they feel less responsible to communicate with others, share their experience, or give advice. This effect was also found by Segerstahl, Kotro, and Vaananen-Vainio-Mattila (2010) who interviewed the users of an online weight loss website. They found that most social support was delivered via discussion forums or blogs, but that many participants evaluate them as not credible and that many participants did not feel connected to the community. In this case, social support limited the effect of an online intervention. Therefore, research plays an important role in examining the different social support features and their effects on effectively implementing online weight loss interventions (Harvey-Berino, Pintauro, Buzzell, & Gold, 2004).

This review will add to this by trying to answer the question of how the elements of social support are implemented in different online weight loss interventions and which of these elements are associated with the effectiveness of these interventions. The focus will be on social support provided in the online interventions through, for example, discussion forums or chats with experts. The challenge being that the participants are anonymous due to the fact that they never meet face-to-face, which could add to the difficulty of creating social support through the various online features found the websites. As described at the beginning, this review will focus on social support the participants receive from other participants.

To operationalize the elements of social support, this review makes use of two different approaches. The first approach focuses on the communication offered on the websites through the different features. Therefore, the categorization of Morrison et al. (2012) was used to determine which subtypes of communication were provided, such as asynchronous communication with peers in discussion forums and synchronous communication with peers in chats, and linking that to the effectiveness of an online intervention. Morrison et al. (2012) already found that automated dialogue components in the form of person-to-person interaction are associated with more effective interventions. Mediated peer-to-peer communication (synchronous- as well as asynchronous) also

showed an association with a positive outcome, although it strongly depended on the perceptions the users had about the credibility and the quality of the advice given to them by the other users.

The second approach attempts to show which elements of social support are used and which are associated with the effectiveness of an online intervention. Lehto and Oinas-Kukkonen (2010) already tried to answer the question of which elements are used and they found that social learning was used on all websites. A participant being able to compare their own performance (social comparison) with the performance of others and being observed by others (social facilitation) is also an important element that helps motivate people to change their behaviour in online interventions (Lehto & Oinas-Kukkonen, 2010). Although research showed that online weight loss interventions use social support as a feature, it did not provide an answer to the question of how this is associated with the effectiveness of an intervention (Kelders, Kok, Ossebaard, & Van Gemert-Pijnen, 2012; Lehto & Oinas-Kukkonen, 2010).

To identify the different elements of social support, this review utilizes the Persuasive System Design Model (PSD-Model) which helps classify technology in its function for social support (Kelders, Kok, & Van Gemert- Pijnen, 2011; Oinas- Kukkonen & Harjumaa, 2009). Persuasive in this context refers to the technology which basically means how technology is designed to persuade people to change their behaviour and stick to the changed behaviour.

By linking the elements of social support to the effectiveness of online weight loss interventions, this review could give an answer to the question of whether social support as a persuasive design feature is used in an effective manner that participants respond to and motivates them to lose weight.
To get a clearer overview of the aim of this review, the research questions will be the following:

- How is social support implemented in online weight loss interventions?
- Which subtype of social support, according to Morrison et al. (2012), is associated with greater effectiveness of an online weight loss intervention?
- Which persuasive elements of social support, according to the PSD, are associated with greater effectiveness of an online weight loss intervention?

Methods

Existing dataset

This study is part of a larger study that examined the relationship between technology and eHealth interventions. Four databases were used to create a dataset: Web of Science, PsycInfo, Scopus and Sciencedirect. A combination of the words 'persuasive technology' and "health" and synonyms were used. Exclusion criteria were (1) not an individual paper, (2) not targeted at a health related behaviour and (3) no link with persuasive technology. There were 270 articles found that matched these criteria.

This review

This review focuses on articles that describe an intervention for weight loss. The search for articles was done using the existing dataset described above. The articles were organized in Endnote. The search words were 'weight loss', 'eating', and 'social support' and could be included in any field, so also in the abstract or title.

Inclusion criteria were (1) that the article was written in English, (2) involved a web- based intervention, (3) the intervention focused on weight loss, (4) the results of effectiveness for the outcome weight loss were reported and (5) that persuasive elements of social support were described. Exclusion criteria were that (1) the authors only described a concept of an intervention (2) the intervention only reported effectiveness for physical activity without having weight loss as an outcome and (3) the articles were a review.

After the selection process, all articles were screened by reading the abstract and title to avoid skipping an important intervention, but no other intervention was found. The excluded reviews were also screened to find more interventions which yielded 6 more articles (Figure 1.)

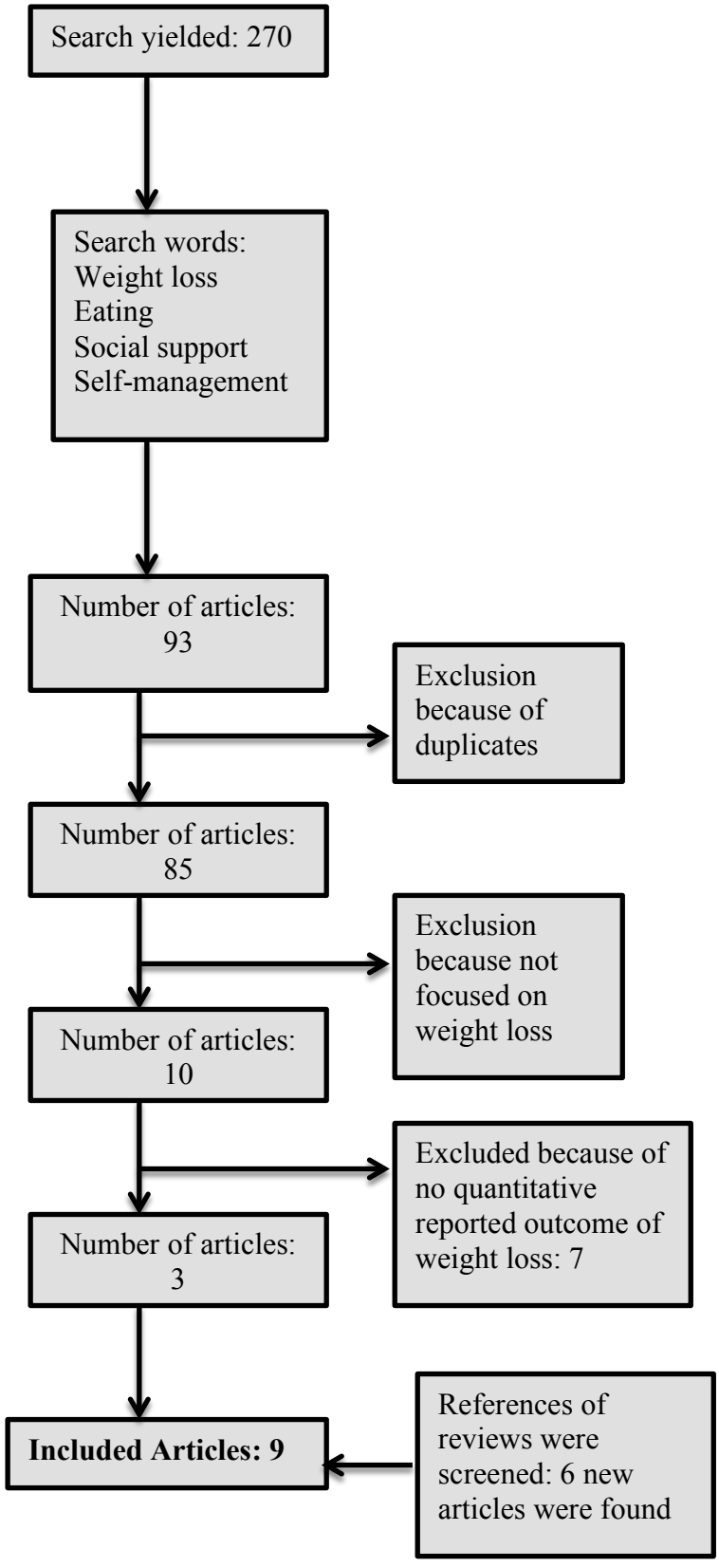

Figure 1. Flowchart article search and selection

As described at the beginning, this review will try to identify the most important elements of social support and show a possible connection between social support and the effectiveness of an intervention for weight loss. In some articles, different online interventions for the treatment and control group were described. In these cases, treatment and control group were categorised as separate interventions if the intervention differed with regard to persuasive elements and content.

The following categories for the data extraction were used:

Study characteristics (per study)

The first category contains general information about the study. This includes information about the sample size, the participants and the purpose of the study.

Groups

The second category contains information about the treatment and the control group. This includes number of participants, name of the intervention, and the technology that was used.

Study Design

The third category gives information about the study design. That means if (1) two or more web-based weight loss interventions within one study were compared, (2) both treatment groups received the same web-based intervention, or (3) one web-based weight loss intervention was compared with the waiting group, who received no treatment. In case of the first, both groups were used.

Social interaction tools (per intervention)

The fourth category gives information about the different tools the participants had for social interaction. This includes information about the opportunities the users have for social interaction with other users and the way they can use things like discussion forums, chats with other members of the interventions or with an expert to ask questions. These detailed information are important for the following category, where these tools where categorized into different subtypes of communication.

Forms of social support

The categorization of Morrison et al. (2012) was used to determine the different subtypes of communication, which are provided through the different tools of social support. A discussion forum for provides asynchronous interaction with peers because it takes time for the other participants to reply. In contrast, a chat with an expert provides synchronous communication because the participants directly receive an answer to their questions. Each subtype may have different influence on the perceived social support of participants and therefore on the effectiveness of online weight loss interventions.

Persuasive technology in the intervention

The PSD framework was used to code the applied principles of social support per intervention.

The persuasive features of social support are shown in Table 1. (Oinas- Kukkonen & Harjumaa, 2009).

Table 1.

Persuasive elements of Social support based upon Oinas- Kukkonen and Harjumaa (2009)

PSD element		**Examples which element are coded when the intervention provided the following opportunity for social support**
Social Learning	Observing others who are performing a target behaviour and seeing the outcome lead to a higher motivation to also perform this behaviour	Discussion Board: Participants have the opportunity to see that people loose weight when following the intervention and do the exercises
Social comparison	A person comparing their own performance with the performance of others leads to a higher motivation to perform the target behaviour	Real time chat with an expert or other participants Opportunities to have a direct comparison of the own performance with the performance of others
Normative influence	By giving people the opportunity to share their goals and feel normal and accepted, they are more motivated to adopt the target behaviour	E-mail feedback to compare the actual performance with the performance that was expected
Social facilitation	If the system discerns that others also perform the target behaviour along with them, people are more motivated to also adhere to this behaviour	Discussion board: Seeing others and have discussion with them helps to motivate participants to perform the same behaviour
Cooperation	People are more motivated if there are opportunities to co-operate	Avatar: Avatar to support participants to achieve their goal and to create an idea of team sense
Competition	People are more motivated if there are opportunities to compete	A table with the participants who lost greatest percentage weight

Recognition	If the target behaviour is recognized and approved by the majority, people are more motivated to adopt the target behaviour	Feedback per e-mail or in form of an avatar to provide the participants the feeling that the behaviour is recognized

The table gives an overview over the attempt of coding of the different PSD elements. The coding of the different principles is based on the descriptions found in the articles about how the features of social support were intended to be used.

Effectiveness

The effectiveness of the interventions was assessed by calculating the effect size per intervention and following the reported outcome per study. The effect size for the differences between pre- and post-test per intervention are presented as Cohen's d. Interventions with d=0.2 were defined as "small effect", d=0.5 as "medium effect" and d=0.8 as "large effect" (Cohen, 1988).

Usage of the web-based intervention (per study)

This category contains information about the actual usage of the features for social support and how this is associated with weight loss according to the authors. This category establishes not only how these features are implemented and how they are associated with the effectiveness of an intervention, but also to examine if participants generally use these features.

Results

The results of this review are presented in Table 2 (Appendix). The most important findings will be summarized here.

The final search yielded nine articles that met all of the inclusion criteria of this review. All articles describe a web based weight loss intervention and were published between 2006 and 2013. Eight articles were about a randomized controlled trial, one article was about a longitudinal observational study. All interventions focus on participants older than 18 years. The duration of the interventions was around eight weeks, with the exception of the longitudinal observational intervention, which lasted 52 weeks. Five out of the nine articles had a treatment and a control group, which both received a web based standard weight loss intervention (I1, I2, I3, I4, I5), but varying specific features on the website, like being supported by an computer assistant (I2) or having access to a weekly chat with an expert (I5). Two out of nine interventions (I8 & I9) compared the treatment with a control group, that didn't receive a behavioural weight loss intervention, but only got information about weight loss. I6 and I7 focussed on differences within the intervention, with regard to the duration of the intervention (I6) and usage of the website (I7). Including the control groups who also received an online intervention, 14 interventions were analysed.

Opportunities for social support and Subtypes of social support (according to Morrison et al. (2012))
In all 14 online interventions at least one feature for social support was available to the participants. Figure 2. gives an overview of the different subtypes of communication according to Morrison et al. (2012) and in what form this was provided in the intervention. In all 14 interventions a discussion form was provided (=message board, Bulletin board), where participants have the opportunity to post their experiences or questions on discussion boards and other members can read and reply to them. This form of communication is described as asynchronous-mediated interaction with peers. Asynchronous-mediated interaction with an expert in the form of feedback via E-mail was used in two of the 14 online interventions. Another popular tool is a web chat which provides synchronous interaction with an expert or with other users of the interventions, which gives the participants the opportunity to directly address questions about the lessons, problems, or their experiences to an expert (I1, I4, I5, I9). Three of the 14 interventions used synchronous communication with an expert. Only one intervention offered the opportunity for synchronous peer-to-peer communication (I9). Only in one intervention simulation of person-to-person contact was done in the form of an iCat for motivational and cooperative feedback (I2).

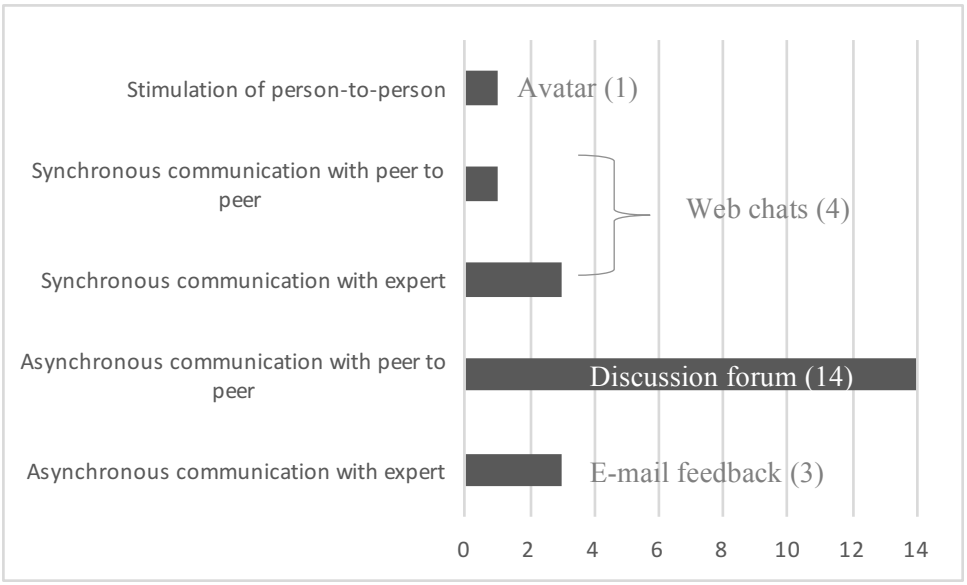

Figure 2. Used subtypes of communication according to Morrison et al. (2012)

Persuasive technology in the interventions

To analyse the different elements of persuasive technology the PSD- model was used (Oinas-Kukkonen & Harjumaa, 2009). The results are shown in Table 3. The description of the features for social support varies between the articles; an overview about the different opportunities for social support gives Table 2 (appendix). Mostly it was only a short description, which made it difficult to code the different elements effectively. Especially the feature "discussion forum" was coded the same for all intervention, because in no article could a proper description be found about how it was intended to be used.

In all 14 online interventions, 44 elements of persuasive technology for social support were employed and all elements were used at least once. The number ranges between two and six elements of the seven principles. In all 14 interventions a discussion forum was provided, where the principles "Social Learning" and "Social facilitation" are implemented. In five out of nine interventions, recognition and normative influence were used.

Table 3.

Persuasive elements of social support

	Social learning	Social comparison	Normative influence	Social facilitation	Cooperation	Competition	Recognition	Total
1.	x	x		x		x		**4**
2.	x			x				**2**
3.	x			x	x		x	**4**
4.	x			x				**2**
5.	x		x	x			x	**4**
6.	x		x	x				**3**
7.	x	x	x	x	x		x	**6**
8.	x			x				**2**
9.	x	x	x	x				**4**
10.	x			x				**2**
11.	x			x				**2**
12.	x			x		x	x	**4**
13.	x			x				**2**
14.	x		x	x	x	x	x	**6**
Total	**14**	**3**	**5**	**14**	**3**	**3**	**5**	**44**

Effectiveness of the intervention

Table. 4 gives an overview of the forms of social support according to Morrison et al. (2012), the used number of persuasive elements, and the effect score for each intervention, when possible. Almost all authors of the 14 interventions report a significant weight loss at the post-test, which indicates that online interventions are effective for weight loss.

Table 4.

Effectiveness of the interventions

	Subtypes of social support		PSD Elements	Effect Size (Within groups)	Effect according to the author (Between groups)
1.	Asynchronous (peer to peer) Synchronous (with an expert)	4	Social learning Social facilitation Competition	-	P= .03 Small effect size (Cohen's d = 0.06), differences between the groups not statistically significant
2.	Asynchronous (peer to peer)	2	Social learning Social facilitation	-	
3.	Asynchronous (peer to peer) Simulation of person to person (Avatar)	4	Social learning Social facilitation Cooperation Recognition	d= 0.3*	With computer assistant decreased BMI statistically significant stronger
4.	Asynchronous (peer to peer)	2	Social learning Social facilitation	d= 0.01	

5.	Asynchronous (peer to peer and expert)	4	Social learning Social facilitation Normative Influence Recognition	Automated Feedback: AF: d= 0.54** Human feedback: HF: d=0.64**	AF and HF significantly lost more weight than the NC (no feedback) group did (p=0.005 and p=0.001), but they differ not from each other (p=0.95)
6.	Asynchronous (peer to peer)	3	Social learning Social facilitation Normative Influence	d=0,28*	
7.	Asynchronous (peer to peer and expert) Synchronous (with an expert)	6	Social learning Social facilitation Normative Influence Recognition	d=0.5**	No significant time x group differences at 6 months (p= .15) or 12 months (p=0.17)
8.	Asynchronous (peer to peer and expert) Synchronous (with an expert) In person meeting	2	Social learning Social facilitation	d=0.3*	BUT all completers in both groups (N=77) significant lose weight (p<.01) at 6 months (7.5±6.4 kg) and at 12 months (6.6 ± 6.6 kg)
9.	Asynchronous (peer to peer) Synchronous (with an expert)	4	Social learning Social facilitation Social comparison Normative Influence	d=0.37*	Groups did not significantly differ from each other (p=0.19) BUT both lost weight from baseline to 16 weeks (p<0.001)
10.	Asynchronous (peer to peer)	2	Social learning Social facilitation	d=0.77**	
11.	Asynchronous (peer to peer)	2	Social learning Social facilitation	-	Weight loss is statistically significant (p< .001) for both groups
12.	Asynchronous (peer to peer)	4	Social learning Social facilitation Competition Recognition	-	Consistent users lose statistically significant more weight than the other users (some, minimal)
13.	Asynchronous (peer to peer)	2	Social learning Social facilitation	d=0.04	No significant difference between treatment and control group
14.	Asynchronous (peer to peer) Synchronous (peer to peer)	6	Social learning Social facilitation Normative influence Cooperation Competition Recognition	-	The whole group lost statistically significant weight (p<.001) but there were no group x time differences (p =408)

Effect score calculated according to Cohen (1988): * small effect; ** medium effect; *** large effect
- Calculating effect size not possible because no standard deviation was reported

Per intervention

For nine out of the 14 interventions it was possible to calculate an effect size out of the pre- and post-test scores within each intervention. Hence, only these nine interventions were used to examine a possible connection between the subtypes of social support, the used PSD elements and the effectiveness of these interventions. Out of the nine interventions, four show a small and three a medium effect for weight loss, whereas two out of the nine interventions show no effect for weight loss. An association between the effectiveness of the intervention and the different features of social support was determined by examining which features were mostly used in the effective interventions.

The results show that out of the four interventions that show a small effect for weight loss, two provided asynchronous contact through a discussion forum (I6 & I8), one synchronous contact with peers in form of a weekly chat group (I1) and one the simulation of person-to-person contact in form of an avatar. Furthermore, besides the PSD elements "Social learning" and "Social facilitation", "Cooperation", "Recognition", "Normative influence", and "Competition" were used.

Out of the three interventions which show a medium effect for weight loss, two used asynchronous contact with peers (I10) or with an expert (I5). One intervention offered the participants in-person contact once a month aside from the normal online intervention. This intervention also showed a medium effect (I7). These interventions also used the PSD-elements "Normative influence" and "Recognition", as well as "Social learning" and "Social facilitation".

Two interventions show no effect for weight loss, each providing asynchronous contact with peers on their websites and both used the PSD elements "Social learning" and "Social facilitation".

The results can indicate that asynchronous-mediated peer-to-peer communication is positively associated with weight loss but it is restrictive to say that almost all interventions are coded as effective, and in all interventions asynchronous peer-to-peer communication in the form of discussion forums were offered, so this result can only be a possible indication and thus needs to be examined further. Furthermore, simulation of person-to-person interaction in the form of an avatar seems effective, although there are no comparable interventions in this review.

Taking the PSD-elements into account, it seems that, besides "Social learning" and "Social facilitation", also "Normative influence", "Recognition" and "Competition" show a positive association with the effectiveness of an intervention because they only were used in the interventions that were coded as effective, but not in intervention that are coded as "not effective". These principles were also used in the other five interventions where a calculation of an effect size was not possible. So these associations are only an indication of a possible connection, which, as mentioned, needs to be examined further.

Comparison between treatment and control groups, which both received different online intervention

The first five studies all compared a treatment and control group with each other, both receiving an online intervention. The single results also gives a good impression about important results gained from the studies. First of all, Hutchesson, Collins, Morgan, and Callister (2013) show that the treatment group lost significantly more weight than the control group. Here, the treatment intervention contains synchronous contact with an expert, in the form of a weekly chat. Furthermore, the PSD element "Competition" was provided, through the reward of a prize for the participant who received the greatest percentage of weight loss. Aside from more persuasive features on the website, the results also suggest that the treatment group shows a greater engagement in website use.

In the intervention described by Blanson Henkemans et al. (2009), where both group had access to the website, it was shown that simulation of person-to-person interaction using avatars and the elements "Cooperation" and "Recognition" was more effective when compared to the control group. Furthermore, it was reported that the treatment group showed a higher frequency in filling out the diary, achieving their daily goals more often and their BMI decreased even more quickly.

Tate, Jackvony, and Wing (2006) showed that, besides asynchronous contact with an expert and the element "Recognition", the total login frequency for completers is positively associated with weight loss.

Micco et al. (2007) examined in their study whether having in-person meetings once a month would decrease the effectiveness of an online intervention. The results show that there were no group differences, which indicates that persuasive features on the website obviated the need for in-person support. They also found that completers, participants who used the intervention regularly, lost significantly more weight.

In the study of Webber, Tate, and Michael Bowling (2008) the treatment and the control group both had access to the online intervention, but the treatment group also had synchronous contract with an expert, in form of a weekly chat. The results show that there was no significant difference between the groups with regard to weight loss, but those within the treatment group who had the chat were associated with greater weight loss. The control group posted significantly more on the message board, which was also associated with weight loss.

Same online intervention for both groups

In two out of the 14 interventions, the groups received the same interventions but different variables to determine whether this has an influence on weight loss. In the intervention described by Neve, Morgan, and Collins (2011) both groups received the same online weight loss intervention, but one group received the intervention for only 12 weeks, and the other for about 52 weeks. Although both groups lost a significant amount of weight, no time differences could be found, but they did find that website use positively correlated with weight loss. Funk et al. (2010) therefore found significant results when comparing participants in their frequencies of website use. They found that the

participants who used the weight loss intervention consistently, also lost significantly more weight than the participants who used the interventions minimally. Looking at the features on the website individually, they also found that participants who logged in more frequently spent more time on exercises and that those who made use of the Bulletin board lost more weight than other participants.

Control group with no online intervention

Two out of the 14 interventions compared an online intervention with a control group, who received no treatment, but only an information newsletter (Kelders, Van Gemert-Pijnen, Werkman, Nijland, & Seydel, 2011; Morgan, Lubans, Collins, Warren, & Callister, 2011). Although both groups lost weight, there were no significant differences in weight loss between the groups, although in the last intervention six different persuasive elements were used (Morgan et al., 2011). Moreover, it was found that men did not actually engage in an online discussion forum, because they think weight loss is a personal endeavour which also stresses an interesting point for future research; namely whether men and women differ in their use of the website features.

Discussion

The aim of this review was to get an overview of the implementation of persuasive elements of social support in web-based weight loss interventions and the relation to the effectiveness of these interventions. To classify the opportunities of social support the different subtypes of communication were categorized with help of a classification of Morrison et al. (2012), as well as the Persuasive Design Model (PSD-Model) (Oinas- Kukkonen & Harjumaa, 2009). This model helps classify the different features for social support into their function, which is trying to persuade the participants for behaviour change, to reach their goal of losing weight.

Principal Results

The review includes nine articles which all describe a web-based weight loss interventions, mostly randomized controlled trials. In total, 14 interventions were analysed, because five of the interventions compared two different online weight loss interventions with each other which both were coded as single online weight loss intervention.

In almost all interventions the participants lost weight after finishing the online intervention, regardless of which interventions they received. This indicates that online weight loss interventions can play an important role in dealing with the problem of overweight, a finding which is supported by earlier research (Harvey-Berino et al., 2004; Saperstein, Atkinson, & Gold, 2007; Verheijden et al., 2005). Online weight loss interventions therefore seem to be a good alternative for offline interventions.

Taking the effectiveness into account, the total number of PSD-elements does not seem to be associated with the effectiveness of the weight loss intervention. However, seeing the single PSD elements, “Normative influence”, “Recognition”, “Cooperation” and “Competition” could indicate on an association with the effectiveness of an online weight loss intervention, because they were all used in the intervention which are coded as effective but none were used in an intervention that was coded as ineffective. The principles “Social Learning” and “Social facilitation” were used in effective as well as ineffective interventions which makes it difficult to relate this to the effectiveness of an online weight loss intervention. A possible explanation of why the four PSD elements are associated with the effectiveness of an online weight loss intervention has already been given in the introduction, namely the Social Learning Theory (Bandura, 1977). Although this theory was founded when online interventions did not exist, it still gives an explanation of how we learn from others. The principle seems to be the same in offline as well as online. Showing how a participant’s own performance matches with the norm (normative influence), and getting recognition through others for successful behaviour change are all implemented in the social learning theory and were used in online interventions which are coded as effective. Providing normative information about other participants has also been found to be effective in a study of (Webb, Joseph, Yardley, & Michie, 2010). The

elements “Cooperation” and “Competition” were provided mostly through giving the participants the opportunity to build up teams (Morgan et al., 2011) or through rewarding the greatest percentage of weight loss with a prize (Hutchesson et al., 2013).

All interventions offered their participants the opportunity for social support in discussion forums (asynchronous communication) and although a general conclusion is not possible because it was used in effective as well as ineffective interventions, two articles revealed that being actively involved in a discussion forum is positively associated with weight loss (Neve et al., 2011; Webber et al., 2008). This points out another interesting factor with regard to the effectiveness of online weight loss intervention, namely the actual participation of the users. Almost all articles show that engagement and usage of the intervention is associated with weight loss (Blanson Henkemans et al., 2009; Funk et al., 2010; Hutchesson et al., 2013; Morgan et al., 2011; Neve et al., 2011; Tate et al., 2006; Webber et al., 2008). Besides providing the features for social support on a website, which seems to be associated with its effectiveness, it seems to be even more important that people actually make use of it, which includes visiting the website regularly, being engaged on the different features like posting, attending to the chats, and, most importantly, following the intervention until the end. Tate et al. (2006) show that this even has long-term consequences, because 6 month after finishing the intervention, the total login frequency on the website was still associated with weight loss for the participants who regularly logged in on the website. In conclusion, this would be an important point to emphasize to the participants at the beginning of an intervention; that not only attending to an intervention, but active participation in the social support features like posting in the forum or doing the exercises can increase weight loss (Saperstein et al., 2007),

However, the features for social support that are most identical with offline weight loss interventions, like synchronous communication, have not been used that much. In this review only four out of the 14 interventions support this kind of synchronous communication interaction with an expert or with other peers, although earlier research has shown that especially synchronous communication with peers in the form of group meetings on chats and forums are a powerful source for behaviour change (Harvey-Berino et al., 2004). Other tools for social support, such as avatars to support the use of the website or feedback on the food diaries the users wrote, were not used that much, possibly because humans are still sceptical towards avatars due to them coming across as unrealistic (Morrison et al., 2012). So it seems to be that although social support seems to be associated with weight loss, it does not have to be similar to offline interventions. Maybe because most participants decide to do online weight loss intervention on purpose, because they want to lose weight for themselves, even when exchanges with other participants also seem to be an important part of online weight loss intervention (Morgan et al., 2011). This would also be supported by the findings of Micco et al. (2007), which showed that in-person support did not increase the effectiveness of the intervention, so social support features seem to compensate the need for contact in person.

To answer the first research question, it can be said that most interventions include a discussion forum, where the PSD principles of "Social Learning" and "Social facilitation" are employed. Knowing that there are many more persuasive elements of social support, there seems to be a lot more room for improvement in online interventions for providing social support. Relating the elements to the effectiveness of the interventions was difficult, considering the heterogeneity of descriptions of the online interventions with regard to the effectiveness. Especially the reported results made it difficult to calculate an effect size to get an objective overview about how effective each single intervention was. In nine out of 14 interventions calculating an effect size was possible and all interventions were found to be effective, which made it difficult to generalize the findings about cause and effect association for the single social support features. There seems to be an association between the elements "Normative influence", "Recognition", "Cooperation" and "Competition" and the effectiveness of the interventions. However, the need for a consistent definition of effectiveness of online weight loss interventions seems to be necessary, considering that other researchers report this problem with regard to effectiveness of online weight loss interventions as well (Neve, Morgan, Jones, & Collins, 2010; Verheijden et al., 2005). Neve et al. (2010) suggest researchers to consult the CONSORT report (Altman et al., 2001) to increase the quality of the described randomized controlled trial and to make it easier for readers to understand the components of the described interventions and to compare the different interventions with each other with regard to the effectiveness. Furthermore, they emphasize a consistent definition for weight loss, regarding the fact that other indicators like body fat or waist circumference can also be indicators of the success of an online weight loss intervention.

Limitations

The first limitation of the review is related to the interpretive categorization of the interventions, which refer to the coding of the persuasive elements and the effectiveness of the interventions. All articles describe different types of interventions, such as interventions with control groups who also received an online intervention or a control group who did not. Furthermore, the reported outcome of weight varies, because while some report means, standard variation from baseline, and post measure, others do not, which makes it complicated to generate an effect size for the outcome of weight loss. Because this was only possible for nine out of 14 interventions, drawing a general conclusion seems difficult, limiting the results.

Finally, the coding of the persuasive elements was done by one researcher and was based on the information in the articles, which can cause limitations due to the different textual descriptions.

Future research

The articles revealed little information about how the different techniques, such as discussion forums or chats, were designed and thus what information the users actually have. This information could

give more insight into why the same feature, such as discussion forums, was evaluated as positive or negative. Research done by Segerstahl et al. (2010) showed that some users evaluate discussion forums not guided by an expert as "uninformative" and "not creditable". They suggest to have the contributions of participants filtered by experts, so that social facilitation of the forums would be promoted. Lehto and Oinas-Kukkonen (2010) made the same suggestion and advised to provide support groups moderated by an expert to avoid that participants feel stigmatized through the anonymity. Also, we found that social support features were not always evaluated as positive because weight loss is seen as a personal endeavour (Morgan et al., 2011).

Most research on online weight loss interventions has concentrated on the relation between social support and weight loss, and, like in this review, when social support was provided on the website it often had a positive influence on weight loss. This review adds to this by showing how the single PSD elements and the type of communication provided to the effectiveness of an intervention and finding out that some elements seem to have a more positive influence on the effectiveness of online weight loss interventions than others do. Furthermore, it was revealed that, besides providing social support on the website, many more factors influence success; factors such as participation and usage of the features. Further research should focus on opening the "Black Box", how participants use the intervention and what ingredients work and which do not. This could, for example, be done through more qualitative research. The results would allow us to not only draw conclusions about which social support features are associated with the effectiveness of online weight loss intervention, but what features work most effectively.

Appendix

Table 2.
Data extraction table

	Study	Study characteristics	Groups		Measurement	Opportunities for social interaction		Form of social support according to (Morrison et al., 2012)	Usage of Web-based intervention
			Treatment Group	Control Group		Treatment group	Control group		
1./2.	(Hutchesson et al., 2013)	**Purpose**: Effect of an 8 week challenge for weight loss **Participants:** adults aged 18-74 years with a body mass index > 18.5kg/m2 **Duration**: 8 weeks **Study design**: Randomized controlled trial	N=381 (SC) Shannan Ponton Fast Track 8 weeks Technology: Website	N=952 (BLC) Standard behavioural weight loss program with persuasive features Technology: Website	Comparison of two web-based weight loss interventions	Discussion forum Weekly video blogs with real – time chat Board with prize for members who receive greatest percentage weight loss	Discussion board Historical online meetings hosted by an accredited practicing dietitian could be viewed by BLC participant	Asynchronous (Peer to Peer) AND Synchronous (with an expert)	Treatment group show greater engagement in website use
Results: Both groups lost weight, but weight loss for SC participants was significant greater (P=.03)									
3./4.	(Blanson Henkemans et al., 2009)	**Purpose**: Can a persuasive computer assistant increase adherence and self-management outcomes?	With computer assistant in form of an iCat N =65 Technology: Website www.dietinzicht.nl online diary	No computer assistant N=53 Technology: Website www.dietinzicht.nl online diary	Comparison of two web-based weight loss interventions	Discussion forum iCat for motivational and cooperative feedback	Only website without iCat	Stimulation of person-to-person contact	Treatment group show higher frequency in filling out the diary, achieved their daily goals more

		Participants: Dutch overweight adults (N=118) **Study design**: randomized controlled trial **Duration**: 12 weeks							often and BMI decreased even stronger

Results: Both groups lost weight, but with computer assistant BMI decreased statistically stronger ($p < 0.001$)

5./6.	*(Tate et al., 2006)*	**Purpose**: Effect of computer tailored feedback to support weight loss **Participants:** N=192 **Study design**: randomized controlled trial **Duration**: 12 weeks	AF: Computer automated e-mail feedback (N= 61) AND HF: Human e-mail counselling (N=64) Technology: One group face- to –face session and Slim Fast Web Site	NC: No counseling (N=67) One group face- to –face session and Slim Fast Web Site	Comparison of three web-based weight loss interventions	E-buddy network system: enabled users to match themselves with other people in the US with similar characteristics and act as peer support for weight loss through e-mail Message board Electronic dairy for which they received weekly e-mail feedback Group 2: computer automated e-mail feedback	Same opportunities but without feedback on the diary	Asynchronous (peer to peer and expert)	Completers: at 6 month total login frequency is associated with weight loss

						Group 3: human e-mail counselling			
		Results: Weight loss significantly differs by group, AF and HF significantly lost more weight than NC group at 3 months							
7./8.	*(Micco et al., 2007)*	**Purpose**: To determine if Internet obesity interventions alone or the addition of limited in-person support is more effective. **Participants:** > 18 years, BMI between 25 and 39.9 kh/m2; N=123 **Study design**: randomized controlled trial **Duration**: 12 weeks	Internet + in person support (N=61) Technology: Website VTrim	Internet (N=62) Technology: Website VTrim	Comparison of three web-based weight loss interventions	Discussion board Weekly online chats to review the lessons which include stimulus control, relapse prevention, problem solving and social support E-mail feedback on the diary	Same online opportunities + once a month in-person meetings	Asynchronous (peer to peer) AND Synchronous (with an expert)	
		Results: No significant time x groups differences at 6 month, but all completers in both groups (N=77) lost statically significant weight							
9./10.	*(Webber et al., 2008)*	**Purpose**: To determine if the addition of weekly motivationally enhanced chats to a standard behavioural Internet weight loss program increases the effect **Participants:** woman, N=66 **Study design**: Randomized	Behavioural therapy website + weekly chat group (N=33); Technology: Initial one face- to –face session and website	Behavioural therapy website (N=33) Technology: Initial one face- to –face session and website	Comparison of three web-based weight loss interventions	Message board Weekly chat group with a moderator who guides the discussion	Message board	Asynchronous (peer to peer) AND Treatment group: Synchronous (with an expert)	Control group significantly more times to the message board than treatment group → number of posts to the website was associated with greater weight loss in both groups Treatment:

		controlled trial						Attending to chat was associated with greater weight loss
		Results: Groups did not significantly differ from each other (p=0.19) BUT both lost weight from baseline to 16 weeks (p<0.001)						
11.	*(Neve et al., 2011)*	**Purpose**: effectiveness of a web-based weight loss program **Participants:** between 18-75 years and a BMI > 22kg/m2 (N=9599) **Study design**: longitudinal observational study **Duration**: 12 weeks and 52 weeks	12 weeks (N=6943) *Technology:* Web –based weight loss platform www.biggestloserclub.com.au	52 weeks (N=2656) *Technology*: Web –based weight loss platform www.biggestloserclub.com.au	Same web-based weight loss intervention only duration of program differs	Discussion forums	Asynchronous (peer to peer)	Percentage weight change was positively correlated with number of days each website feature was used
		Results: Weight loss in both groups is statistically significant (p< .001)						
12.	*(Funk et al., 2010)*	**Purpose**: Comparison between groups of a weight loss intervention that use the website consistent, sometimes or almost never **Participants:** > 18 years, BMI of 25 or greater **Study design**: randomized clinical trial **Duration**: 30 month	Part of a long term weight loss program but with focus only on Internet condition (N=348) Technology: Website	No control group	Same web-based weight loss intervention	Bulletin board Homepage "Hub" that displayed participants profiles for other users	Asynchronous (peer to peer)	Regardless of outcome measure, those in the consistent category had better weight outcomes compared with the other categories

		Results: 51% of the consistent users of the website showed significant weight loss at 4 kg							
13.	*(Kelders, Van Gemert-Pijnen, et al., 2011)*	**Purpose**: Effect of the Healthy Weight Assistant (HWA) **Participants:** > 18 years, BMI of 18.5 – 28 kg/m2, Dutch speaking; N=269 **Study design**: randomized clinical trial **Duration**: 12 weeks	N = 127 Technology: web –based lifestyle intervention (Healthy Weight Assistant HWA)	Waiting list group N= 142 12 weeks newsletter	Comparison of web-based weight loss intervention with waiting list group	Discussion Forum	Newsletter	Asynchronous (peer to peer)	Not reported
		Results: No significant differences in weight loss between the groups							
14.	*(Morgan et al., 2011)*	**Purpose**: 12-Month Outcomes and Process Evaluation of the SHED-IT (Self-Help Exercise, and Diet using Internet Technology) RCT: an Internet-Based Weight Loss Program Targeting Men **Participants:** > 18 years, only men (N=65), BMI between 25 and 37 kg/m2 **Study design**: randomized controlled trial **Measuring**: 12	Internet group n = 65 Technology: Face-to-face information session and weight loss program booklet Website www.calorieking.com.au SHED (Self- Help Exercise, and Diet using Internet Technology)	Information only control group (N= 31) Technology: Face-to-face information session and weight loss program booklet	Comparison of web-based weight loss intervention with waiting list group	Discussion Forums Public blogs Groups Live chats Success stories		Asynchronous (peer to peer) AND Synchronous (peer to peer)	Men did not engage in online discussion board because they think weight loss is a personal endeavor

month,

Results: The whole group lost statistically significant weight ($p<.001$) but there were no group x time differences ($p=.408$)

Table. 5
Overview data out of the articles

	Treatment group	Control group	P value for differences between groups
(Hutchesson et al., 2013)	SC (N=381) Absolute (Kg): -5,1 (-5.5-4,6)	BLC (N=1334) Absolute (Kg): -4.5 (-4.8, -4,2)	P= .03 Small effect size (Cohen's d = 0.06), differences between the groups not statistically significant
(Blanson Henkemans et al., 2009)	N=35 BMI at the beginning: 28.39 (SD = 2.32) BMI at the end: 27.78 (SD = 2.32)	N=35 BMI at the beginning: 28.23 (SD = 2.36); BMI at the end: 28.16 (SD = 2.49)	F (1,28) = 13.84, p < 0.001 With computer assistant decreased BMI statistically significant stronger
(Tate et al., 2006)	AF Baseline: 89.0 (13.2) 3 months: -5.3 ± 4.2 (47) 6 months: -4.9 ± 5.9 (44) HC Baseline: 89.0 (13.0) 3 months: -6.1 ± 3.9 (56) 6 months: -7.3 ± 6.2 (5.2)	NC Baseline: 88.3 (13.9) 3 months: -2.8 ± 3.5 (55) 6 months: -2.6 ± 5.7 (59)	Weight loss differed significantly by group (F=9.4, p< 0.001) 3 month: AF and HF significantly lost more weight than NC group did (p=0.005 and p=0.001), but differed not from each other (p=0.95) 6 month: Weight loss significantly different in HC and NC (p<0.001) AF differed not significantly from NC or HC condition (AF vs NC p=.16 and AF vs HC p=.15)
(Micco et al., 2007)	Baseline: 86.1±12.8 6 months: -6.8 ± 7.8 kg 12 month: -5.1 ± 7.1 kg	Baseline: 92.0±15.7 6 months: -5.1 ± 4.8 kg 12 month: -3.5 ± 5.1 kg	No significant time x group differences at 6 months (p= .15) or 12 months (p=0.17) BUT all completers in both groups (N=77) significant lost weight (p<.01) at 6 month (7.5±6.4 kg) and at 12 month (6.6 ± 6.6 kg)
(Webber et al., 2008)	Baseline: 82.1 ± 13.6 16 weeks: -3.71 ± 4.46 kg	Baseline: 82.5 ± 8.4 16 weeks:	Groups did not significantly differ from each other (p=0.19) BUT both lost weight from baseline to 16 weeks (p<0.001)

		-5.22 ± 4.72 kg	
(Neve et al., 2011)	12 weeks: -5.6 Kg (-5.8 kg to -5-5kg) 52 weeks: -8.4 kg (-9.0 kg to -7.8 kg)		Weight loss is statistically significant (p< .001)
(Funk et al., 2010)	51% of the consistent users of the website showed significant weight loss of 4 kg		P= .002 compared to the others who didn't use the website tools that consistent
(Kelders, Van Gemert-Pijnen, et al., 2011)	BMI, mean SD Pretest: 24.0 (2.4) Posttest: 24.1 (2.5)	BMI, mean SD Pretest: 23.9 (2.5) Posttest: 24.0 (2.5)	ES: 0.07 (-0.10 -0.24)
(Morgan et al., 2011)	12 month (95 % CL) -5.3 (-7.5, -3.0)	12 month -3.1 (-5.4, - 0.7)	The whole group lost statistically significant weight (p<.001) but there were no group x time differences (p =408)

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