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RESEARCH

What is the evidence for personalised technological devices in the management of obesity? A rapid review

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SUMMARY

The following key messages are based on the findings of this rapid review:

1. Self-monitoring is central to any intervention in weight management.
2. Lack of adherence to dietary regimens has been the most significant challenge in weight management.
3. Smartphones have the potential to support weight management plans.
4. No significant differences were found in the literature between interventions deploying information technology (IT) and non-IT interventions on weight management.

Key Words
Personalised technological devices; management; obesity

ABSTRACT

Background

The optimal approach to weight management has not yet been identified. The research question for this rapid review was: What is the evidence for personalised health promotion in obesity? The following PICO format was used:

- Population—overweight and obese adults (BMI ≥ 25) aged 18 years and older
- Intervention—any form of information technology targeting weight loss for a period of at least three months
- Comparison—no information technology used for assistance in weight loss
- Outcome—weight loss.

Aims

This review considers the effectiveness of novel methods to manage obesity, particularly focusing on information technology and smartphones in primary health settings.

Method

CINAHL and MEDLINE databases were searched for articles published between 2009 and 2015. The journals Obesity and Journal of Medical Internet Research were independently searched. In addition, manual searches from bibliographies of the included studies, important systematic reviews and meta-analyses were conducted. In total, 223 articles were identified.

Conclusion

Regular self-monitoring is currently seen as the most effective strategy leading to weight loss in overweight and obese populations. Both IT and non-IT methods are available, but there is no evidence to suggest that one is more effective than the other at instigating this weight loss.

BACKGROUND

Worldwide obesity has more than doubled since 1980.[1] In 2014, more than 1.9 billion adults, 18 years and older, were overweight.[1] Of these more than 600 million were obese.[1] As a direct result, at least 2.8 million people die each year from complications related to being overweight or obese.[1]

Central to this growing problem is that, while obesity is preventable, effective strategies to manage the problem are limited. Currently, the practice of regular self-

monitoring is recognised as the most effective intervention for instigating weight loss in overweight and obese populations.[2] Traditionally, self-monitoring has occurred through the use of non-electronic methods, such as paper-based diaries and surveys.

Technological interventions in weight loss are promising new mediums to promote and sustain weight management in the primary care setting.[3] Unlike traditional non-electronic methods, interventions delivered through mediums such as smartphones, email, and the internet have the advantage of being more appropriately tailored to each individual.[4] A review of information technology (IT) and its effect on behavioural modification has revealed three major areas of difference when compared to traditional methods; personalisation, feedback, and adaptation.[5]

The role and impact of IT within society continues to grow. A recent survey from the United States (US), reported that 58 per cent of Americans own a smartphone and that ownership rates are increasing across all socioeconomic groups.[6] This trend is mirrored in Australia, where recent surveys have suggested that from 2011 to 2012, ownership rates of smartphones have more than doubled.[7] In 2015, a series of surveys reported 95 per cent of Australian households have a computer, 72 per cent of Australians own a smartphone, and 56 per cent own a tablet.[8]

In many healthcare problems, the solution lies in getting people to make and maintain healthy choices rather than continuing with risk-taking behaviours. Functional magnetic resonance imaging (MRI) studies of the human brain have identified that humans are resistant to change even when the change might be in their best interests. Change requires the investment of energy. There are three stages to adopting new behaviours:[9]

1. Unfreezing current patterns/unlearning old behaviours;
2. Change/applying new behaviours; and
3. Embedding new behaviours.

Of these information technology might get people underway with the first step by getting them to question the status quo.[10]

It is encouraging that preliminary studies have identified a strong association between adherence to self-monitoring and weight loss. It would appear that technological devices can improve this adherence.[11] As a result of improved self-monitoring enabled by IT, there may be direct and beneficial effects on weight loss after 12 months.[5] It is therefore reasonable to postulate that technological interventions can promote weight control (Appendix A). However, without strong experimental evidence we cannot be sure that these preliminary observations are repeated and robust.

METHOD

This review includes data from articles published between 2009 and 2015. The EBSCOhost platform was used to search the databases Medline and CINAHL with the following medical subject headings (MeSH) search strategy:

(overweight+ [mesh heading (mh)] OR obesity [mh] OR weight reduction program [mh])

and

(cellular phone+ [mh] OR cellular phones+ [mh] OR smartphone+ [mh] OR computers, hand-held+ [mh] OR computers, handheld [mh] OR computers, portable+ [mh] OR minicomputers [mh] OR microcomputers+ [mh] OR software [mh] OR mobile applications [mh]).

The journal Obesity and the Journal of Medical Internet Research (JMIR) were searched using the terms overweight+ OR obesity OR weight reduction program.

After removing duplicates, the search retrieved 223 articles.

Before undertaking the primary relevance assessment, a filter was applied to identify citations which only involved adult populations ≥18 years. Teenagers and children were excluded from the search to allow the focus to be placed on adults attending primary healthcare services.

Ninety articles remained for primary relevance assessment. Titles and abstracts were reviewed for the following inclusion criteria:

1. The article focused on measuring the effect of personalised technological devices on weight management;
2. Weight loss was the primary outcome measure;
3. Randomised controlled trials;
4. Follow-up of greater than three months;
5. The sample size was >50.

If inclusion was uncertain from the abstract alone, the full article was read and a consensus reached between the two reviewers.

Following full text review, nine documents were deemed relevant. Five further articles were identified through manually searching the bibliographies of the included studies, important systematic review, and meta-analyses.[2,11] Refer to Appendix B and C for the detailed search strategy.

RESULTS

Of the 223 relevant citations retrieved, 14 randomised controlled trials (RCT) of 1,854 participants were included in the rapid review. Characteristics of the trials are described in Table 1. The trials published between 2009 and 2015, varied in size from 51 to 365 participants. The studies, in accordance with the inclusion criteria, had a minimum duration of three months, and ranged up to 24 months. Most studies were conducted in the US. Intervention frequency, feedback requirements, and parameters assessed varied significantly across studies.

Of the 14 trials, the majority were published in the last three years. Most studies included a combination of IT mediums to comprise an intervention that was to be compared to a non-IT intervention. Most (n=13) used mobile phones, many (n=12) included text messages, and some (n=3) used e-mail and mobile phone applications (n=4). Of these trials, there was no consensus on the impact of IT and non-IT interventions upon weight reduction. More than half of the studies (n=9) suggested that IT did have a positive impact on weight loss; however, the remaining studies (n=6) suggested that there was in fact no difference between IT and non-IT based interventions. No studies suggested that non-IT interventions were more effective than IT interventions.

The frequency at which a particular intervention for weight management took place was of particular importance, impacting the effectiveness of that intervention. Many studies, which showed favourable outcomes in the intervention group, had such interventions occurring much more frequently than those in the control group. For example, in a randomised controlled trial conducted by Steinburg et al,[20] a substantial difference in mean weight loss was demonstrated in the intervention group, compared to the control group, over a six-month period (–6.55 per cent vs. –0.35 per cent). There were also significant differences in the frequency of interventions performed for each group. Those in the intervention group received daily feedback via email, internet software, and electronic scales linked to their smartphone; as well, 22 weekly lessons were sent to their smartphone throughout the duration of the six-month period.[20] In comparison, those participants in the control group received three handouts on physical wellbeing over the six-month period.[20] The majority of studies that indicated a significant difference between intervention and control had adopted a similar pattern, whereby the intervention groups received a much higher frequency of feedback than those in the control groups. There may be benefit for future research comparing electronic and non-electronic interventions at comparable frequencies to determine if it is the frequency of interventions that affects weight loss irrespective of the method of delivery.

In terms of establishing the effectiveness of personalised technological devices, this review restricted its analysis to weight loss, in terms of percentage and kilogram lost from baseline following the intervention. Several studies also included waist circumference, total energy expenditure and total caloric intake as a means of assessing the effectiveness of interventions. There were no significant relationships found between these additional parameters across studies. As such, these parameters were not formally addressed in this review.

DISCUSSION

Eight studies demonstrated that IT interventions facilitate weight loss, while six studies found no difference in weight reduction between IT and non-IT interventions. There was also no difference in weight reduction across short-term (three month) and longer-term (12 month) trials. The studies reviewed here suggest that the evidence for

effectiveness of IT interventions is equivocal.

In the research reviewed the frequency at which IT and non-IT interventions were received by the various study populations was not consistent. Of the eight studies, which identified that IT interventions did have a more significant impact on weight loss, IT interventions were delivered to participants much more frequently than non-IT interventions. No studies compared IT and non-IT interventions delivered at similar frequencies. It is therefore unclear whether the results of the studies suggesting the benefit of IT interventions was due to the IT interventions themselves or rather due to improving the self-monitoring behaviour of the study cohort. Furthermore, several of the IT interventions that were shown to be effective consisted of multiple IT devices used in combination, such as a smartphone application in conjunction with regular emails. Importantly non-IT interventions did not consist of a combination of mediums. This may have further contributed to improved self monitoring in the study populations who were receiving IT based interventions.

IT based interventions are constantly evolving. Smartphones have a much greater capacity, and the technology is getting faster, cheaper, and more advanced.[8] There remains potential for technology to influence weight reduction positively with its particular advantages over traditional paper-based interventions through personalisation, feedback, and adaptation.[5] As IT becomes more accessible for all socioeconomic groups, so, too, does its integration in daily life. This integration may have an ability to strongly influence behavioural change, particularly with reference to more effective self-monitoring.

The selection criteria of this review excluded studies with participants under the age of 18. Notably, adolescents may be more likely to deploy technological interventions than adults.[26] Secondly, there were no participants above 65 years of age included in the selected randomised controlled trials. The role of technological devices in managing obesity in the elderly population has therefore not been adequately explored. Thirdly, as part of the exclusion criteria, studies had to have a cohort size of at least 50 participants. This would have excluded any published qualitative or pilot studies.

Interpretation of the evidence from the selected trials was limited by the variability in primary outcomes measured and the frequency at which results were recorded. There was a large variation in the length of the trials, ranging from three to 24 months. Weight management interventions aim for long-term results, in terms of maintaining a healthy weight and avoiding a relapse into unhealthy habits. Therefore, for health clinicians, interventions shown to produce an effect on weight loss over a longer duration may be more relevant in the primary health setting.

Studies that directly compare IT and non-IT interventions at similar frequencies are required to gain a better understanding of the effectiveness of IT in managing overweight and obese individuals. The may be additional benefit of comparing specific IT mediums alone, rather than in combination, to give an indication as to which IT interventions are most worthwhile. Future studies could explore the relationship between IT interventions and their effect on additional outcomes measures, including weight loss, waist circumference, diet, exercise, and patient satisfaction. From an economic perspective, the cost of implementing IT software for weight loss on a large scale also needs more clarity.

CONCLUSION

In conclusion, this rapid review has identified that current IT interventions are not superior to traditional non-IT interventions in facilitating weight loss in overweight and obese populations. It is important to note, however, research in this field is relatively limited and there is still scope for IT-based interventions to develop as the technology

evolves. It must also be acknowledged that information alone is unlikely to alter behaviour and accordingly, the information facilitated through IT interventions has to be available to patients at a time when they feel ready and able to take the requisite action.

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PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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Not required

Table 1: Effectiveness of weight loss interventions

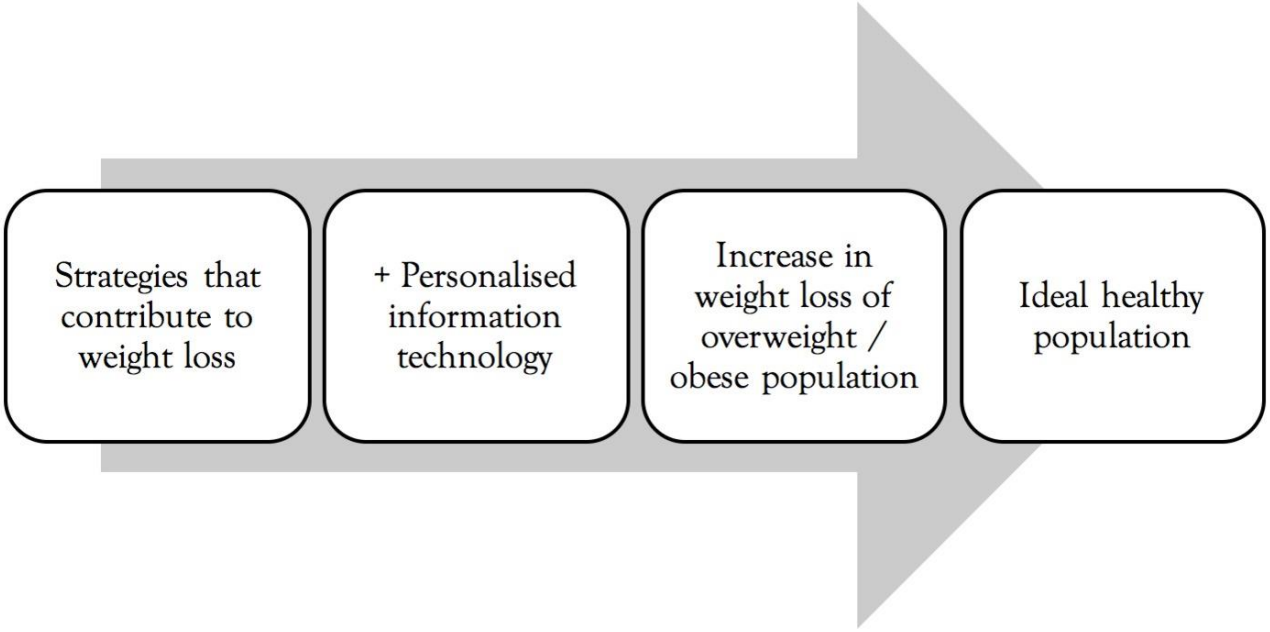
Study	Population, Duration	Intervention	Control	Outcomes Reported	Summary
Laing et al[12] 2014, USA RCT	N = 212 BMI > 25 Age > 18 6-month follow-up	Smartphone application: MyFitnessPal	Self-directed weight loss with one follow-up at 3 months	Mean weight change at 6 months in Control: +0.27% Intervention: –0.03%	No significant change between intervention and control
Lin et al[13] 2014, China RCT	n=123 BMI >24 Age 30–50 6-month follow-up	3 group sessions 5 coaching calls Daily text message	Brief advice session following randomisation	Mean weight change at 6 months in Control: +0.21% Intervention: –2.3%	Intervention caused a loss in weight, decreased waist circumference and lowering of blood pressure
Spring et al[14] 2013, USA RCT	n=70 BMI 25–40 Age 28–86 3-, 6-, 9-, 12-month follow-up	Personalised mobile technology system, biweekly weight loss group sessions	Biweekly weight loss group sessions	Mean weight change at 12 months in Control: –0.29kg Intervention: –2.9kg	Personalised technological devices used for weight loss were shown to be more effective than group sessions
Acharya et al[15] 2011, USA RCT	n=192 BMI >25 Age 18–59 6-month follow-up	Personal Digital Assistant for self-monitoring	Paper based monitoring	Mean weight change at 6 months in Control: –5.94% Intervention: –6.71%	Both IT and paper-based interventions were effective; no difference between intervention and control groups were found
Gabriele et al[16] 2011, USA 3 arm RCT	n=104 BMI 25–40 Age 30–60 3-month follow-up	1. Directive e-coach: Personalised for each participant, with daily follow up in regards to weight, exercise and diet 2. Minimal e-coach Support: Weekly e-mail and feedback	Non-directive: participant driven	Mean weight change at 3 months in Control: –2.19% Minimal e-coach: -2.47% Direct e-coach: –4.76%	A directive e-coach support is associated with more significant weight loss than less directive interventions
Norman et al[17] 2013, USA RCT	n=52 BMI 25–39.9 Age 25–55 4-month follow-up	2–5 weight management text messages per day	Received via mail 1–2 pages of print materials each month for 4 months	Mean weight change at 4 months in Control: –1.39% Intervention: –5.09%	Regular text-messaging that promoted healthy eating strategies resulted in greater weight loss
Haapala et al[18] 2009, Finland RCT	n=125 BMI 26–36 Age 2–-44 12-month follow-up	Mobile phone operated weight loss program	No intervention	Mean weight change at 12 months in Control: –1.3% Intervention: –5.4%	The mobile phone intervention had a significant impact on weight loss and waist circumference

Table 1: Effectiveness of weight loss interventions (cont'd)

Study	Population, Duration	Intervention	Control	Outcomes Reported	Summary
Patrick et al[19] 2009, USA RCT	n=75 BMI 25–39.9 Age 25–55 4-month follow-up	Personalised SMS & MMS sent 2–5 times daily, printed materials and brief monthly phone calls from a health counsellor	Receipt of monthly printed materials about weight control	Mean weight change at 4 months in Control: –1.01% Intervention: –3.16%	Intervention was shown to be more effective in causing weight loss than control
Turner-McGrievy et al[20] 2011, USA RCT	n=96 BMI 25–45 Age 18–60 6-month follow-up	Podcast and mobile phone application	Podcast only	Mean weight change at 6 months in Control: –2.7% Intervention: –2.7%	Additional prompting and mobile communication did not enhance weight loss
Steinberg et al[21] 2013, USA RCT	n=91 BMI 25–40 Age 18–60 6-month follow-up	Cellular connected smart scale, web-based graph of weight trends, weekly tailored feedback via email, 22 weekly e-mail on behavioural weight control via email	Provided with scales at baseline, self-directed weight loss	Mean weight change at 6 months in Control: –0.35% Intervention: –6.55%	Daily intervention via technological medium was shown to produce clinically significant weight loss
Svetkey et al[22] 2015, USA 3 arm RCT	n=365 BMI ≥25 Age 18–35 24-month follow-up	1. Personal coaching intervention via smartphone 2. Cell phone intervention only	Provided with 3 handouts on healthy eating and physical activity	Mean weight change at 24 months in Control: –1.44% Intervention 1: –2.45% Intervention 2: –0.99%	Cell phone intervention did not lead to weight loss and personal coaching did not achieve a significant difference in weight loss as compared to the control
Hebden et al[23] 2013, UK RCT	n=51 BMI 23–31 Age 18–35 12-week intervention	Printed diet booklet, dietitian session, four-weekly SMS and e-mails, access to smartphone applications and internet forums	Printed diet booklet, dietitian session	Mean weight change at 12 weeks in Control: –1.4 kg Intervention: –1.6kg	Positive changes in weight, nutrition and physical activity but no different to those observed among controls
Carter et al[24] 2013 3 arm RCT	n=128 BMI ≥27 Age 18–65 6-month intervention	MMM app which incorporates goal setting, self-monitoring of diet and activity, feedback via weekly text-message	1. Website group: access to information via websites 2. Diary group: paper food diary with calorie counting book	Mean weight change at 6 months in Diary group: –2.9kg Website group: –0.3kg MMM app intervention group: –4.6kg	The MMM is an acceptable and feasible weight loss intervention with more research being required
Shapiro et al[25] 2012 RCT	n=170 BMI 25–39.9 Age 21–65 12-month follow-up	Daily interactive and personally weight-relevant text-messages	Monthly e-newsletters	Mean weight change at 12 months in Control: –1.0kg Intervention –1.65kg	Text-messaging had no effect on weight loss

E-coach=Electronic Coach; RCT=Randomised Control Trial; MMM=My Meal Mate, SMS=Short Messaging Service; MMS=Multimedia Messaging Service

Appendix A: Concept model of weight loss intervention using technology



Appendix B: Search strategy

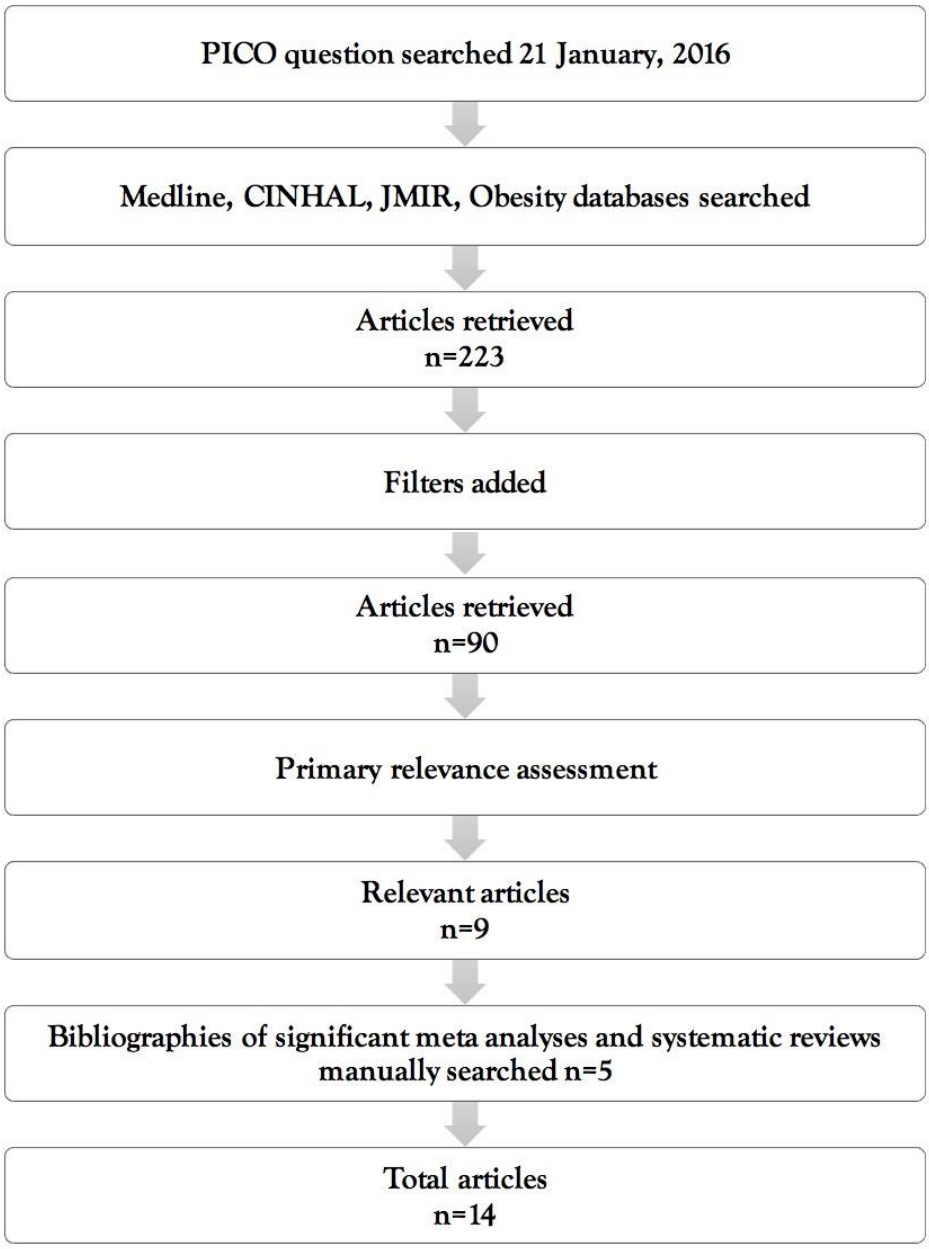
Medline and CINAHL databases were searched using the following MESH terms:

Overweight+ OR obesity+ OR weight reduction program

AND

Cellular phone+ OR cellular phones+ OR smartphone+ OR computers, hand-held+ OR computers, handheld OR computers, portable+ OR minicomputers OR microcomputers+ OR software OR mobile applications

Appendix C: Literature search flowchart



- Filter
  - Adult 18+
- Primary relevance assessment
  - Title and abstract screened
- Selection criteria
  - Article focused on the effect of personalised technological devices on weight management
  - Primary outcome measure was weight loss
  - Randomised controlled trials
  - Follow-up was > 3 months