saxinstitute

Evidence Check

Changing behaviour by telephone: what works

An **Evidence Check** rapid review brokered by the Sax Institute for Healthdirect Australia. December 2015.

An **Evidence Check** rapid review brokered by the Sax Institute for Healthdirect Australia.
December 2015.

This report was prepared by:
Yael Benn, Jilly Martin, Abigail Millings, Paul Norman, Thomas L Webb

December 2015

Enquiries regarding this report may be directed to the:
Head
Knowledge Exchange Program
Sax Institute
www.saxinstitute.org.au
knowledge.exchange@saxinstitute.org.au
Phone: +61 2 91889500

Suggested Citation:
Benn Y, Martin J, Millings A, Norman P, Webb TL. Behaviour change techniques for telephone-delivered and supported health coaching interventions: an Evidence Check review brokered by the Sax Institute (www.saxinstitute.org.au) for Healthdirect Australia, 2015.

Behaviour change techniques for telephone-delivered and supported health coaching interventions

An **Evidence Check** rapid review brokered by the Sax Institute for Healthdirect Australia.
December 2015.
This report was prepared by Yael Benn, Jilly Martin, Abigail Millings, Paul Norman, Thomas L Webb

Contents

Glossary of terms 1

Acronyms 1

Statistical terms 1

Theory-related terms 2

1 Executive summary 3

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone? 3

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone? 4

Question 3: What tools can be used to make a decision about which BCTs should be employed and when? 4

2 Introduction 5

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone? 5

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone? 6

Question 3: What tools can be used to make a decision about which BCTs should be employed and when? 6

3 Methods 8

Table 1: Search terms and filters 8

Table 2: Inclusion and exclusion criteria 9

Figure 1: Flow of information through the review 11

Data extraction 12

Identifying the effectiveness of the interventions 12

Coding study characteristics 12

4 Results 13

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone? 13

Moderators of the effect of telephone-delivered interventions on behaviour 13

Table 3: Effect sizes (*d*) representing the effect of telephone-delivered interventions on diet and physical activity 15

Table 4: Categorical moderators of the effect of telephone-delivered interventions on diet and physical activity. 16

Which BCTs were most effective? 16

Table 5: Sample-weighted average effects (d_+) associated with the use of different BCTs in telephone-delivered interventions targeting healthy weight 17

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone? 18

Table 6: Effect sizes (*d*) for the effect of telephone-delivered interventions on pregnant women and parents of young children 19

Outcome measure 19

d 19

A self-help workbook ('Towards Parenthood', Milgrom et al.[72]), from which eight units were to be read during pregnancy and one following birth. Weekly phone calls were used to discuss the units' content with a psychologist or trainee psychologist. Calls lasted approximately half an hour and allowed for tailored discussion and problem-solving around the unit content 19

Intervention: Involved one two-hour teaching session. Following the session, telephone support was provided by the study coordinator, twice a week for two weeks 21

Results of the effects of interventions providing antenatal and postnatal support 24

Results of interventions providing support to parents of infants and toddlers 24

Question 3: What tools can be used to make a decision about which BCTs should be employed and when? 25

5 Discussion 26

The effect of telephone-delivered interventions targeting healthy weight 26

The effects of interventions providing antenatal and postnatal support 27

Interventions providing support to parents of infants and toddlers 27

The evidence with respect to the tools used to assist decision-making regarding which BCT should be employed, and when 28

6 Conclusion 29

Question 1 29

Question 2 29

Question 3 29

7 References 30

Glossary of terms

Acronyms

BCT	A Behaviour Change Technique is a method of attempting to alter a person's behaviour. An extensive typology of 93 different BCTs is reported by Michie et al.[1]
ECBI	Eyberg Child Behavior Inventory
PAI	Parental Anger Inventory
PS	Parental Scale
TCQ	Toddler Care Questionnaire
RCT	Randomised Control Trial
REA	Rapid Evidence Assessment

Statistical terms

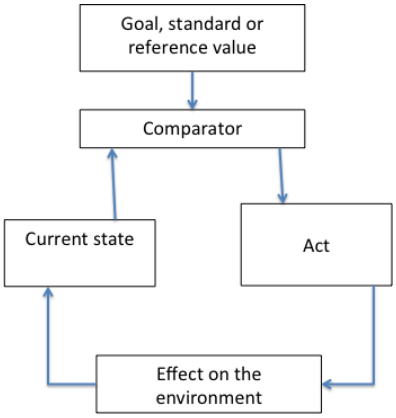
d_+	Sample-weighted average effect size. See page 12 of the review for full explanation Small effect size: $d_+ = 0.20$ Medium effect size: $d_+ = 0.50$ Large effect size: $d_+ = 0.80$
k	Number of studies used to compute the effect size
95% CI	95% confidence interval. The upper and lower values represent the +/- 2 standard deviation from the mean respectively
Q	A measure of heterogeneity, i.e. to what degree there is dispersion across effect sizes
Meta-analysis	A statistical technique for pooling the findings across multiple studies in order that overall effects can be estimated
Moderator	A variable that interacts with the effect of the primary variable of interest on the outcome variable so as to change the effect of the primary variable on the outcome. For example, if gender moderated the effect of social support on dieting, then social support would have a different effect on dieting for males as it would for females
Categorical variable	A variable that comprises of categories rather than a quantitative amount. For example, gender is a categorical variable. Age group (under 18, 18–25, 26–35, 36–45, 45+) is also a categorical variable

Continuous variable	A variable that comprises of a quantitative amount rather than a category. For example, age (not grouped into categories) is a continuous variable. Amount of calories consumed per day is a continuous variable
N_{Exp}	Number of people in the intervention group
N_{Con}	Number of people in the control group

Theory-related terms

Control theory

Control theory[2] is a theory borrowed from engineering and deals with the behaviour of systems with inputs, and how their behaviour is modified by feedback. The name of the theory is derided from its objective: to control a system. In the context of human behaviour, the system is described as follows:



Where the 'comparator' refers to the concept of comparing the current state (e.g. current weight) to the target (desired weight). Therefore, control theory involves setting goals, acting to achieve the goal and monitoring progress: i.e. noting current standing with regards to the goal, and the effect of one's action on the environment

Theory of Planned Behaviour

The Theory of Planned Behaviour[3] holds that behaviour is driven by intention. Intention is determined by attitudes (how we evaluate the behaviour), subjective norms (our perception of what those around us think we should do), and perceived behavioural control (the extent to which the behaviour will be easy or difficult)

Social Cognitive Theory

Social Cognitive Theory[4] proposes that individuals learn by observing others, but that the environment and cognition play important roles in determining behaviour

1 Executive summary

Although telephone-delivered or supported interventions have been used to target a range of health behaviours, little is known about which specific Behaviour Change Techniques (BCTs) – e.g. goal-setting, self-monitoring, social support etc. – are effective in promoting changes in behaviour.

This report uses rapid review assessment methodology to address three key questions:

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone?

- Thirty independent studies were identified that investigated the effect of telephone-delivered or supported interventions that targeted behaviours to promote healthy weight. For each study, we calculated how effective each intervention was in promoting changes in diet and/or physical activity, and we identified the specific BCTs used in each of the interventions using the taxonomy of Michie et al.'s.[1] We used meta-analysis to determine average effect sizes across studies.

- Telephone-delivered interventions had a small-sized, but statistically significant effect on physical activity (d_+ = 0.21), and a medium-sized, statistically significant effect on diet (d_+ = 0.51). Thus, the available evidence indicates that telephone-delivered interventions can be used effectively to change physical activity and diet.

- The most commonly used BCTs involved setting behavioural goals, providing (unspecified) social support and facilitating problem solving. Interventions that provided behaviour substitution, implemented a behavioural contract, or provided information from a credible source were most successful in changing behaviour. However, these BCTs were used by relatively few interventions (two studies or fewer). The following BCTs were used in at least 10 studies, and were successful in changing behaviour: by providing instruction on how to perform a behaviour, prompting self-monitoring of behaviour, goal setting (behaviour or outcome), social support (unspecified), review of behaviour goal(s), problem solving, and action planning.

- More studies are needed to assess the effect of providing behaviour substitution, implementing a behavioural contract and providing information from a credible source, as these were the most successful BCTs in the few studies that used them.

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone?

- Ten studies were identified that examined the effectiveness of telephone-delivered interventions in supporting parents of young children (six studies) and pregnant women (four studies). To identify the success of the studies, we examined outcomes related to parents' wellbeing (e.g. depression and anxiety) and/or the child's behaviour (e.g. disruptive behaviour). We also identified the BCTs used in the interventions. Given the small number of studies, a narrative review was used to synthesise the findings.

- For interventions designed to support the parents of young children, it was noted that even relatively simple telephone-delivered (or telephone-supported) interventions (three of which were based on the Triple P program)[5], can improve both children's behaviour and parent's wellbeing. For reading support, the available evidence suggests that telephone-supported interventions are as effective as other modes of intervention delivery, such as face-to-face or providing printed material. Considering the BCTs used in these interventions, providing helpful and reliable information, prompting problem solving and providing social support were all effective in addressing the child's behaviour and parents' wellbeing. Evidence for the effectiveness of telephone-delivered interventions in supporting the parents of infants under 12 months old was inconclusive, with only one study addressing this question.

- For antenatal and postnatal interventions, three studies reported that telephone-delivered or supported interventions were more effective than control interventions, while a fourth reported that a telephone-delivered intervention was not as effective as an intervention delivered face-to-face. Nine BCTs were used in the studies, with social support (either unspecified, social or practical) and problem solving featuring in all four studies, and providing a credible source of information featuring in two. Verbal persuasion about capability was only used in one study, but it was successful in promoting maternal and infant sleep outcomes.

- The evidence-base for telephone-delivered interventions to support parents is sparse. Further studies are needed with larger samples that target a wider range of outcomes over longer follow-up periods and identify the active elements of an intervention by manipulating/assessing specific BCTs.

Question 3: What tools can be used to make a decision about which BCTs should be employed and when?

- None of the studies included in the review reported using specific tools to determine which BCTs should be employed and when. However, some studies reported using theory to help to identify the determinants of behaviour and to select BCTs.

- Theories that can be used to select BCTs include social cognitive theory[4] and control theory.[2] Previous reviews have indicated that the use of theory in the design of interventions increases their effectiveness.

- The systematic use of theory to (i) identify the determinants of behaviour to be targeted in an intervention and (ii) select the specific BCTs to be used to target these determinants is therefore recommended.

2 Introduction

Telephone-delivered or supported interventions have been used to target a range of health behaviours from smoking to exercise (e.g. Eakin et al.[6], Goode et al.[7]). However, while telephone-delivered interventions have been commonly used in some domains (e.g. to promote weight loss), they have been used less frequently in others (e.g. to support the parents of young children). Moreover, there is little information about which specific strategies – or behaviour change techniques (BCTs) – are effective in promoting changes in behaviour. BCTs are theory-based methods for changing one or several psychological determinants of behaviour, and include techniques such as goal-setting, self-monitoring, and social support.

The current report was commissioned by Healthdirect (via the Sax Institute) in order to inform a new service that is to be provided by Healthdirect. This service aims to deliver telephone-delivered interventions for weight loss and for supporting the parents of young children. As such, the present report reviews the evidence for the effectiveness of different BCTs in interventions delivered primarily via telephone[a] that:

- Target weight loss in adults (defined as those aged 16+), with particular interest in interventions targeting young adults between the ages of 16–18 (Question 1)
- Provide support to pregnant women and the parents of young children (Question 2).

The review also seeks to identify tools that have been used to aid the choice of BCTs in telephone-delivered interventions (Question 3).

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone?

Promoting changes in physical activity and dietary behaviour are considered to be the primary methods for the prevention and management of many prevalent chronic conditions, including obesity, diabetes[8] and cancer.[9] A substantial body of research supports the efficacy of interventions targeting physical activity and dietary behaviour across a range of settings, target populations and intervention modalities (e.g. Kahn et al.[10]). Many of the modes of delivery (e.g. mailed print materials, computer-tailored and internet-delivered interventions) have the potential to reach a wide population. Telephone-delivered interventions also have this potential, but unlike the other modes of delivery, may also provide an element of tailored care and social support.

Over the past 10 years, several systematic reviews of interventions designed to promote physical activity and changes in dietary behaviour have been published in which the telephone was the primary method of intervention delivery (e.g. Eakin et al.[6], Goode et al.[7]). These reviews provide evidence that the telephone is an effective method for delivering interventions designed to promote weight loss by promoting changes in behaviour (e.g. Eakin et al.[6]) and that such interventions are cost effective (e.g. Goode et al.[7], Graves et al.[11]). However, none of the existing reviews have examined the relative effectiveness of specific BCTs, nor have they examined whether the effectiveness of the interventions depends on the nature of the target population. As such, it is difficult to know which BCTs are effective in promoting changes in behaviour in

[a] A separate short review covering interventions delivered via other technologies such as internet and mobile phone applications is provided in Appendix 1.

which populations. Therefore, the current review will examine the effectiveness of specific BCTs, as well as seek to examine their effectiveness among different target populations (e.g. people of different ages). In addition, the review will examine the effectiveness of additional modes of delivery (e.g. print materials, internet etc.) that can be used to supplement telephone-delivered interventions.

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone?

Providing support to parents can be an effective strategy for promoting various behaviours, such as increasing fruit and vegetable consumption among children[12] or reducing behavioural problems in children and depression in parents.[13] However, traditional means of delivering interventions to parents, such as educational sessions, often report high rates of drop-out[14] and low levels of attendance (e.g. due to barriers associated with transport, work schedules and lack of interest).[15] Telephone-delivered interventions may overcome many of these barriers and provide a convenient and effective means for parents to receive support.

Previous research has found that providing telephone support to parents is an effective method for promoting fruit and vegetable consumption in young children.[16] There is also some evidence to suggest that telephone-delivered interventions can provide support for the carers of people with clinical needs including children who stutter (e.g. Lewis et al.[17]) and children with autism (e.g. Giarelli et al.[18]). A systemic review by Dennis and Kingston[19] found that telephone-delivered interventions had a significant positive effect on breastfeeding practices as well as postnatal depression (although the latter effect was based on a single pilot study), but did not promote smoking cessation or improve pre-term delivery rates. To date, however, there has not been a systematic review of the evidence on the effectiveness of telephone-delivered interventions for supporting the parents of healthy children.

Therefore, in the current report, we systematically review findings from available studies to provide an overview of the existing evidence and highlight gaps in current research where this is appropriate. The review covers evidence in two main categories: (i) support for pregnant women and early postnatal care and (ii) support for parents of children between the ages of 2–8. These were separated, as the issues raised in the two categories differ slightly. For example, in supporting pregnant women, one may consider the best time to begin the delivery of intervention or whether the intervention should be targeted at the women only, or at both parents. In examining the effectiveness of the interventions, we consider the BCTs used, the mode of delivery (telephone with or without face-to-face contact, written materials or a combination of these), and the target behaviour, which includes aspects of cognitive development (e.g. development of language), physical characteristics (e.g. sleeping, crying) and disruptive behaviours (e.g. ADHD symptoms). In addition, we report the effect of the interventions on parenting style, and parents' emotional and cognitive state where these were measured.

Question 3: What tools can be used to make a decision about which BCTs should be employed and when?

One of the main challenges in developing an effective intervention is to select appropriate BCTs. For example, when is it appropriate to prompt people to set goals and when would it be more effective to provide social support? A full exploration of this issue is beyond the scope of the present review (but for an example of a relatively comprehensive approach, see Michie et al.[20]); instead, this report highlights a few key

principles. First, it is important to identify the proximal determinants of the behaviour in question. For example, if fruit and vegetable consumption among children is primarily a function of the behaviour of those around them, then it would be appropriate to select BCTs that target this putative determinant of behaviour (e.g. shaping). In contrast, if fruit and vegetable consumption among children is primarily a function of motivation (and thus problems accrue from a lack of motivation), then BCTs might be selected so as to provide information on the importance of eating fruit and vegetables, and prompting relevant goal setting.

There are a number of frameworks and theories for understanding the determinants of behaviour (e.g. the Theory of Planned Behaviour, Ajzen)[3] that might help in identifying BCTs for targeting these behaviours. Although some of these theories have been criticised for not specifying how such putative determinants might be modified (e.g. Sniehotta et al.[21]), the use of theory in general provides a promising tool for informing decisions about which BCTs should be employed and when (for a review, see Prestwich et al.[22]) as there is evidence that the use of theory is associated with more effective interventions (e.g. Webb et al.[23]). The present review will therefore consider which BCTs are effective in promoting changes in behaviour, how interventions select BCTs, and the extent to which theory is used to shape the design of interventions.

3 Methods

The present review used Rapid Evidence Assessment (REA) methodology (Burton et al.[24], Hailey et al.[25], Khangura et al.[26]) to review the evidence base on the three questions identified. REA uses similar methods and principles to a systematic review but makes concessions to the breadth and depth of the process in order to be completed within a short timeframe. As such, the current review includes only those studies that were published in English, in a peer-reviewed journal, and dating from 2005. While the REA can help to inform policy and decision making by synthesising the evidence in a relatively short space of time, it is not necessarily as exhaustive as a full systematic review or meta-analysis.

The sample of studies for the present review was generated via an electronic search of Web of Science in September 2015. Six search filters were used (see Table 1). First, we identified studies involving telephone-delivered interventions (Filters 1 and 2). We then combined this search with interventions targeting weight-loss (Filter 3) or energy-balance behaviours (Filter 4) or with interventions providing support to parents (Filter 5) or targeting parents' or children's behaviour (Filter 6). To be included in the review, studies had to include a term from Filter 1 and 2, along with a term from Filter 3 and 4 (Question 1) or Filter 5 and 6 (Question 2). After conducting searches, studies were evaluated according to the inclusion and exclusion criteria described in Table 2.

Table 1: Search terms and filters

	Search Terms
Filter 1: Telephone	*phone*mobile, telephon*, call cent*
Filter 2: Intervention	intervention, trial, experiment, behavi* change strateg*, random* controlled trial*
For Question 1:	
Filter 3: Weight	*weigh*, obese*, body mass index, BMI
Filter 4: Energy balance behaviours	diet, fruit, vegetable, low-fat, calorie, sport, exercise, fitness, walking, physical activity, healthy eat*
For Question 2:	
Filter 5: Parenting support	parent*, care*
Filter 6: Parenting or child behaviour	life adjustment, stress, anger, relationships, speech, language, sleep, crying, toilet training

Table 2: Inclusion and exclusion criteria

Inclusion criteria for all studies:
1. The main components of the intervention must be delivered by telephone. This may be supported by some face-to-face, online, or mobile application components 2. The intervention must incorporate at least one BCT as defined by Michie et al.[1] 3. Studies must either randomly allocate participants to intervention or comparison conditions that differ in at least one BCT (i.e. adopt a between-participants design), or measure (behavioural) outcomes before and after an intervention (i.e. adopt a within-participants design) 4. The manuscript must report sufficient information to compute an effect size 5. The manuscript must be published in a peer-reviewed journal dating from 2005, or be a study conducted by Health Change Australia 6. The manuscript must be written in English
Inclusion criteria for Question 1:
1. The intervention must target weight loss 2. The study must measure at least one of the following behaviours: diet, physical activity, or reporting/retention in the program 3. Participants must be aged 16 or above
Exclusion criteria for Question 1:
1. Interventions delivered to clinical populations (e.g., patients with cancer, mental health problems, diabetes etc.) were excluded, due to the potential confounding effect of, for example, medication
Inclusion criteria for Question 2:
1. The intervention must provide support to parents, to include interventions targeting parents' behaviour (e.g. life adjustment, stress and anger management, relationships) as well as those targeting children's behaviour and development (e.g. speech, sleep, crying, toilet-training) 2. The study measures a relevant behaviour in the wake of the intervention 3. Participants are pregnant women or parents, grandparents, and other caregivers of children aged 0–5 years
Exclusion criteria for Question 2:
1. Interventions where the parent, caregiver or child is enrolled in a program targeting a clinical diagnosis (e.g. postnatal depression or other mental health condition, or speech therapy targeting speech problems) were excluded, but interventions that were intended to address the management of behaviours or stress that may accompany these conditions were included

Figure 1 shows the flow of information through the review. Of the 3486 articles initially identified, 17 duplicates were removed. We then screened the remaining 3469 articles, of which 342 articles were identified as potentially eligible for inclusion. The majority of articles rejected at this stage used the telephone to measure outcomes rather than to deliver the intervention (e.g. Betzold et al.[27], Abildso et al.[28]). The remaining 342 articles were then evaluated in detail. At this stage, studies were mainly rejected because the intervention did not target weight loss (e.g. Albright et al.[29]), the target population was not parents of

young healthy children (e.g. the intervention was delivered to parents of teenagers[30]) the study focused on a clinical population (e.g. Anderson et al.[31]), or the telephone was not the main way in which the intervention was delivered (e.g. Dennison et al.[32]).

As a result, 26 articles (describing 30 independent studies[b]) that examined the effectiveness of telephone-delivered interventions for weight loss in adults were identified for inclusion in the review addressing Question 1 (What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone?), and 10 studies that examined the effectiveness of telephone-delivered interventions for ante- and post-natal women, and parents of young children were identified for inclusion in a review addressing Question 2 (What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone?).

[b] Three studies (listed below) used more than one intervention (e.g. intense exercise and moderate exercise) and compared results to a control condition. In these cases, an effect size was calculated comparing each intervention separately with respect to the corresponding control condition:

33. Jakicic JM, Marcus BH, Lang W, Janney C. Effect of exercise on 24-month weight loss maintenance in overweight women. Archives of internal medicine. 2008;168(14):1550-9; discussion 9-60.

34. Paineau DL, Beaufils F, Boulier A, Cassuto DA, Chwalow J, Combris P, et al. Family dietary coaching to improve nutritional intakes and body weight control: a randomized controlled trial. Archives of pediatrics & adolescent medicine. 2008;162(1):34-43.

35. Simpson SA, McNamara R, Shaw C, Kelson M, Moriarty Y, Randell E, et al. A feasibility randomised controlled trial of a motivational interviewing-based intervention for weight loss maintenance in adults. Assessment HT, editor. Southhampton, UK: NIHR Journals Library; 2015.

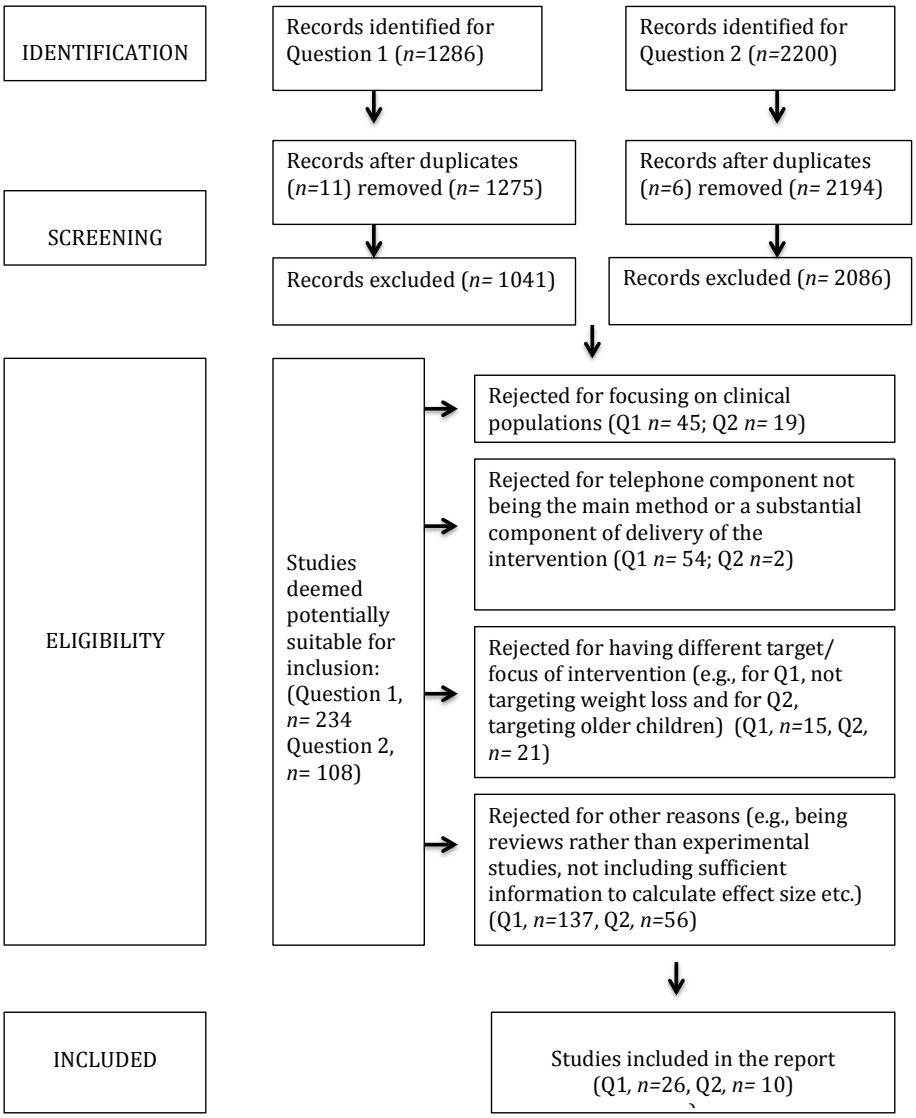


Figure 1: Flow of information through the review

Data extraction

Identifying the effectiveness of the interventions

The effectiveness of the interventions was evaluated by computing an effect size representing the effect that the intervention had on the outcome of interest. The advantage of using effect sizes is that they are 'standardised' and so permit comparison between the effects reported in different studies, which may otherwise be represented by different statistics. The present review used Cohen's *d* to represent the size of the difference between the means of two groups (e.g. intervention and control). Cohen's *d* is calculated using the sample size, the mean outcomes of the groups (for example, the number of active minutes per day) and the respective standard deviation for that outcome measures. A larger '*d*' indicates a stronger effect. Following Cohen's[36] recommendations, $d = 0.20$ was taken to represent a small effect size, $d = 0.50$ a medium effect size, and $d = 0.80$ a large effect size. We used these qualitative indexes to interpret the findings.

The review addressing Question 1:

As described above, effect size *d* was used to represent the effect of the interventions (relative to the comparison conditions or pre-intervention measures) on physical activity and/or diet. Meta-analysis was then used to estimate the average effect of telephone-delivered interventions targeting weight loss on physical activity and/or diet. Meta-analysis provides a sample weighted average effect size (d_+) that represents the typical effect that might be expected, based on the existing evidence base. Sample-weighted average effect sizes were computed using SPSS version 20 and the macros developed by Wilson.[37] The effect of continuous variables (e.g. the age of participants) on the effect sizes was tested using a series of weighted linear regression models regressing the effect size representing the effect of the intervention on the moderator. In other words, we examined the extent to which variables that might influence the overall effect of a given intervention (such as age) would change each effect size. The moderating effects of categorical variables (e.g. whether the nature of the recruitment procedures influenced the effectiveness of the intervention), was evaluated by dividing the studies based on levels of the categorical moderator and conducting a separate meta-analysis on each subgroup. This report does not compare subgroups that were represented by only a single study, but does report the effect sizes for information.

The review addressing Question 2:

As before, effect size *d* was used to represent the effect of the interventions, this time on outcomes related to parents' wellbeing (e.g. depression and anxiety) and/or the child's behaviour (e.g. disruptive behaviour). However, given the relatively small number of studies examining the effects of telephone-delivered interventions designed to support parents, we computed effect sizes for each of the primary studies but did not use meta-analysis to quantitatively synthesise the findings. Instead, the effect of these interventions was evaluated in a narrative review.

Coding study characteristics

We identified the specific BCTs employed by each of the interventions using Michie et al.'s[1] taxonomy of BCTs. We coded only BCTs that differed between the intervention and comparison conditions and could, therefore, explain any differences in their impact on behaviour. We also recorded the age of participants, the design of the study (Randomised Control Trial [RCT] or before-after design), and whether the participants initiated their participation in the intervention or whether they were referred to, or were approached to take part in the intervention.

4 Results

The Glossary of terms provides an explanation of the terms used in this section to report the results.

Question 1: What BCTs have been shown to be effective in interventions designed to promote healthy weight delivered via the telephone?

Table 3 presents information on the number of participants and the nature and effectiveness of each intervention included in the review. On average, telephone-delivered interventions had a small-sized, but statistically significant impact on physical activity (d_+ = 0.21, k = 23, 95% CI: 0.06 to 0.36, $Q(22)$ = 7.52, p = .99) and a medium-sized, statistically significant effect on diet (d_+ = 0.54, k = 25, 95% CI: 0.29 to 0.79, $Q(24)$ = 63.44, p < .001).

Moderators of the effect of telephone-delivered interventions on behaviour

To examine which factors influence the effect of telephone-delivered interventions on behaviour, we first computed the sample-weighted mean effect of the interventions on behaviour (i.e. diet and physical activity combined which was d_+ = 0.45, k = 30, 95% CI: 0.24 to 0.67, $Q(29)$ = 65.77, p < 0.001). We then evaluated the impact of various moderators on this combined effect (rather than evaluate whether factors influence the effect of the interventions on diet and physical activity separately). Table 4 summarises the findings.

Age

The average age of participants in the primary studies was 41.49 (SD = 12.70, range 16–64). To compare the effect of interventions on younger versus older samples we divided the studies into those where the sample was, on average, aged 20 or under, and those where the sample was, on average, aged 21 and over. Age did not significantly moderate the effect of intervention on behavioural outcomes (p = .51) and interventions had comparable effects on both young and old participants (d_+ = 0.23 and 0.55, respectively).

Recruitment

The way that participants were recruited for the studies (i.e. self-referral or recruited by a researcher or a health professional) did not significantly influence the effect of interventions on behaviour (self referral d_+ = 0.52; recruited d_+ = 0.02; p = .26). However, it should be noted that, while several studies (k = 6) used a mixed recruitment procedure (i.e. some participants were recruited, while others self referred), in only two studies was the full sample self-recruited.

The use of additional modes of delivery

Face-to-face

Eleven studies used face-to-face contact alongside the telephone-delivered intervention components. The addition of face-to-face contact did not significantly moderate the effect of the interventions on behaviour (with face-to-face d_+ = 0.36, without face-to face, d_+ = 0.50, p = .57).

Print material

Eleven studies provided printed materials alongside the telephone-delivered intervention components. Providing printed materials did not significantly influence the effect of the intervention on behaviour (with print material, $d_+ = 0.62$, without print material, $d_+ = 0.35$, $p = .25$).

Internet

Providing intervention material on the internet alongside the telephone-delivered intervention components significantly influenced the effect of the interventions on behaviour ($p = .001$). Studies combining telephone-delivered intervention components with internet-delivered components typically reported a larger effect of the intervention on behaviour ($d_+ = 1.20$) than telephone-delivered interventions that did not including internet-delivered components ($d_+ = 0.31$).

Study design

The design of the study (RCT or before-after) did not significantly influence the effect of intervention on behaviour (RCT $d_+ = 0.46$; before-after $d_+ = 0.43$; $p = .91$).

Table 3: Effect sizes (*d*) representing the effect of telephone-delivered interventions on diet and physical activity

Authors (year)	N_{Exp}	N_{Con}	Effect size on behaviour	
			Physical activity	Diet
Boutelle et al.[38] (2005)	13	13		0.55
Buscemi et al.[39] (2011)	28	32	0.04	0.37
Carpeneter et al.[40] (2014)	1070		0.11	0.33
Damschroder et al.[41] (2010)	14		0.34	0.64
Damschroder et al.[42] (2014)	160	160	0.11	0.64
Dawes et al.[43] (2015)	33	23	0.76	
Deforche et al.[44] (2005)	10	10	0.17	
Dekkers et al.[45] (2011)	37	39	0.05	0.12
Gerber et al.[46] (2013)	42	41		0.20
Groeneveld et al.[47] (2010)	206	223	0.11	0.48
Jakicic et al.[33] (2008) moderate intensity, high duration	46	47	0.27	0.25
Jakicic et al.[33] (2008) vigorous intensity, high duration	48	47	0.30	0.27
Jakicic et al.[33] (2008) vigorous intensity, moderate duration	50	47	0.22	0.21
Kim et al.[48] (2010)	579	577	-0.12	0.15
Liu et al.[49] (2015)	11		0.44	0.49
Lutes et al.[50] (2012)	21		0.30	0.59
Newman et al.[51] (2008)	230			1.16
O'Hara et al.[52] (2012)	1440		0.30	0.45
O'Hara et al.[53] (2013)	277		0.08	-0.02
Paineau et al.[34] (2008), group A vs. control	116	186		2.21
Paineau et al.[34] (2008), group B vs. control	98	186		2.57
Partridge et al.[54] (2008)	123	125	0.37	
Pearson et al.[55] (2013)	25	20		0.30
Sangster et al.[56] (2015)	137	145	0.08	
Simpson et al.[35] (2015), intensive vs. control	45	51	0.09	0.29
Simpson et al.[35] (2015), less intensive vs. control	43	51	0.84	0.24
Smith et al.[57] (2009)	34	11	0.81	1.39
Ströbl et al.[58] (2013)	228	239	0.30	
van Weir et al.[59] (2011)				0.03
van Wier et al.[60] (2009)	459	457	0.32	0.08

Note: N_{Exp} = Number of people in the intervention group, N_{Con} = Number of people in the control group. Effect size, colour coded: small effect size, medium effect size, large effect size.

Table 4: Categorical moderators of the effect of telephone-delivered interventions on diet and physical activity.

Moderator	d_+	+/-95% CI		k	d_+	+/-95% CI		k
Age	Age 20 and under				Age 21 and over			
	0.23	-0.68	1.14	3	0.55	0.23	0.87	18
	Q for comparison = 0.44, p = .51							
Recruitment	Self-recruitment				Recruited by researcher/medical staff			
	0.52	0.23	0.80	2	0.02	-0.78	0.83	22
	Q for comparison = 1.29, p = .26							
Face to face contact	Face to face contact				No face to face contact			
	0.36	-0.04	0.76	11	0.50	0.24	0.76	19
	Q for comparison = 0.32, p = .57							
Print material	Provided printed materials				Did not provide printed materials			
	0.62	0.27	0.96	11	0.35	0.07	0.63	19
	Q for comparison = 1.34, p = .25							
Internet	Internet support				No-internet support			
	1.20	0.70	1.69	4	0.31	0.10	0.52	26
	Q for comparison = 10.40, p = .001							
Design	RCT				Before-after			
	0.46	0.21	0.71	23	0.43	-0.03	0.90	7
	Q for comparison = 0.12, p = .91							

Note: k= Number of studies, d_+ = Sample weighted average effect size, colour coded: small effect size, medium effect size, large effect size.

Which BCTs were most effective?

To examine the impact of different BCTs on the effectiveness of telephone-delivered interventions targeting weight, we computed the sample-weighted average effect size representing the effect of the interventions on the behaviours of interest (namely diet and physical activity) as a function of each BCT. The findings from these analyses are shown in Table 5. The most commonly used BCTs involved setting behavioural goals (73% of studies), providing (unspecified) social support (70%) and facilitating problem solving (57%). The largest effects on behaviour were observed for interventions that provided behaviour substitution (d_+ = 2.38, 95% CI: 1.83 to 2.93), implemented a behavioural contract (d_+ = 0.76, 95% CI: -0.59 to 2.11) or provided information from a credible source (d_+ = 0.96, 95% CI: -0.16 to 1.53). However, these BCTs were used by relatively few interventions (k = 2, 1, and 2, respectively). Providing instruction on how to perform a behaviour, prompting self-monitoring of behaviour, goal setting (behaviour or outcome), social support (unspecified), review of behaviour goal(s), problem solving and action planning all had effects on behaviour that exceeded d_+ = 0.20, and were used by 10 or more interventions.

Table 5: Sample-weighted average effects (d_+) associated with the use of different BCTs in telephone-delivered interventions targeting healthy weight

BCT	*k*	*Q*	95% CI		d_+
25: Behaviour substitution	2	0.43	1.83	2.93	2.38
71: Behavioural contract	1	0	-0.59	2.11	0.76
74: Credible source	2	1.52	-0.16	1.53	0.69
36: Instruction on how to perform a behaviour	8	22.50	-0.29	1.07	0.68
10: Self-monitoring of behaviour	16	23.28	0.25	0.86	0.56
32: Avoidance/reducing exposure to cues for the behaviour	2	0.01	-0.62	1.65	0.52
66: Goal setting (behaviour)	22	26.79	0.24	0.74	0.49
9: Feedback on outcome(s) of behaviour	1	0	-1.24	2.18	0.47
23: Behavioural practice/ rehearsal	1	0	-1.24	2.18	0.47
56: Non-specific incentive	1	0	-1.24	2.18	0.47
8: Feedback on behaviour	6	1.89	-0.03	0.93	0.45
3: Social support (unspecified)	21	25.51	0.18	0.70	0.44
29: Graded tasks	2	0.01	-0.50	1.29	0.40
13: Monitoring outcome(s) of behaviour by others without feedback	2	0.15	-0.52	1.25	0.36
69: Review behaviour goal(s)	10	2.18	-0.05	0.72	0.33
65: Problem solving	17	4.71	0.05	0.60	0.32
11: Self-monitoring of outcome(s) of behaviour	5	0.56	-0.28	0.89	0.30
15: Prompts/cues	1	0	-0.76	1.37	0.3
68: Action planning	10	0.47	-0.11	0.66	0.28
75: Pros and cons	2	0.01	-0.57	1.09	0.26
67: Goal setting (outcome)	10	1.31	-0.09	0.58	0.25
82: Information about health consequences	3	0.03	-0.46	0.92	0.23
40: Verbal persuasion about capability	1	0	-0.79	1.23	0.22
81: Identity associated with changed behaviour	1	0	-1.12	1.53	0.21
59: Material reward (behaviour)	1	0	-1.40	1.74	0.17
5: Reduce negative emotions	3	0.11	-0.41	0.70	0.15

Note: *k*= Number of studies. BCTs are ordered by d_+ = Sample-weighted average effect size, colour coded: small effect size, medium effect size, large effect size.

Question 2: What BCTs have been shown to be effective in interventions designed to support parents delivered via telephone?

Ten studies investigated the efficacy of telephone-delivered interventions providing support to parents. Table 6 provides a summary of the characteristics of these interventions, along with effect sizes. Four interventions provided antenatal and postnatal support (Collado et al.[61], Guttentag et al.[62], Milgrom et al.[63], Stremler et al.[64]), and six provided support for the parents of young children, mostly up to the age of five years old (Hall et al.[65], Huebner and Meltzoff[66], Kierfeld et al.[67], Morawska and Sanders[68, 69]; although in one study this was extended to parents of young children up to the age of eight (Gallart and Matthey).[70] We reviewed interventions targeting these two groups of participants separately, as they raise slightly different questions and challenges.

Table 6: Effect sizes (*d*) for the effect of telephone-delivered interventions on pregnant women and parents of young children

Author (year)	Sample	Intervention	BCT[1]	N_{Exp}	N_{Con}	Outcome measure	*d*
Interventions delivered to pregnant women							
Guttentag et al.[62] (2014)	At risk pregnant women (adolescents or adults of low socio-economic/ education background)	Intervention began at the third trimester of pregnancy and continued until the child was 30 months old **Face-to-face group**: Sessions focused on changing specific aspects of the mothers' responsive behaviours to their children and employed the Play and Learning Strategies (PALS) curriculum (Landry et al.[71]). This involved demonstration of behaviour, and one-to-one intensive support **Telephone group**: support to mothers followed a systematic format for each call, asking a standard set of questions about the parent's current status and the child's developmental progress. Coaches were trained to provide supportive, nondirective responses during these calls and to refrain from giving specific parenting advice	Telephone-delivered intervention compared to face-to-face: None differed (Face-to-face group compared to telephone-delivered intervention: 1, 8, 36, 65, 74, 88)	(Telephone group) 180	(Face-to-face group) 181	Parent–child interaction Children's social–emotional and cognitive functioning	-0.21 -0.12
Milgrom et al.[63] (2011)	Pregnant women	A self-help workbook ('Towards Parenthood', Milgrom et al.[72]), from which eight units were to be read during pregnancy and one following birth. Weekly phone calls were used to discuss the units' content with a psychologist or trainee	3, 36, 65	36	72	Depression Stress Anxiety Parenting stress index	0.60 0.59 0.58 0.46

		psychologist. Calls lasted approximately half an hour and allowed for tailored discussion and problem-solving around the unit content					
Collado et al.[61] (2014)	Couples in which the women were identified to be at postnatal depression risk by validated interview	**Intervention**: Began during the second term of pregnancy. Couples participated in 10 small group sessions of two hours and 15 minutes each, with a follow-up phone call between sessions to encourage attendance and record any unusual incidents **Control**: Couples attended eight sessions of two hours each, focusing on childbirth and pregnancy health, during the third term of pregnancy	1, 2, 65, 86	69	58	Depression Stress Marital relationship: - Men - Women Preterm childbirth	0.32 0.11 0.29 0.20 0.55
Stremler et al.[64] (2006)	First-time mothers and their infants	**Intervention**: 45-minute face-to-face meeting in the hospital followed by weekly telephone calls from the study nurse (weeks 1–5 after hospital discharge), to reinforce the information given, answer questions **Control**: Brief (10 minutes) meeting with the study nurse to discuss maternal sleep hygiene. Mothers also received a one-page pamphlet with this information and a phone call from the study nurse at weeks three and five	1, 2, 36, 40, 65, 74	15	15	Amount and quality of sleep (parents) Mother rate sleep as a problem Infants no. of night-time awakenings Infant maximum lengths of night-time sleep	3.01 0.88 3.83 3.01

Interventions delivered to the parents of infants and toddlers							
Gallart and Matthey[70] (2005)	Parents of children age 2–8	Four group sessions based on the Triple P programme (Sanders and Markie-Dadds[5]), with or without four telephone support sessions	3	Group session + phone 16	Group session no phone 17	Depression anxiety stress scale ECBI (intensity) Parenting style	0.01 0.24 0.26
Hall et al.[65] (2006)	Parents of 6–12-month-old infants	**Intervention:** Involved one two-hour teaching session. Following the session, telephone support was provided by the study coordinator, twice a week for two weeks	3, 11, 37, 65, 74	35		Parent's sleep quality Depressive mood Fatigue Cognitions about infant sleep	1.05 0.84 1.05 1.12
Huebner and Meltzoff[66] (2005)	Parents of two- or three-year-old children	Intervention based on Dialogic Reading for two- and three-year-old children (Whitehurst et al.[73]), and an instructional video ('Hear and Say Reading with Toddlers', Huebner[74]) designed to encourage interactive reading **Self-instruction with telephone follow-up group**: Received the instructional video and a children's book by mail along with a letter stating that a staff member would telephone them in approximately one week to see how the new reading style was working out and to answer any questions. One telephone contact was attempted in each of the two four-week reading periods. The duration of the telephone calls was brief (max. five minutes). At the conclusion of each call parents were encouraged to keep reading **Self-instruction only condition:** Same material but did not receive telephone follow-up	1	30	32	Parent–child reading style Child total number of utterances Child longest 5 utterances	0.09 0.18 -0.02

Kierfeld et al.[67] (2013)	Parents of preschool children with externalising problem behaviour	**Intervention**: Parents received a 305-page self-help book (Dopfner, Schurmann, and Lehmkuhl[75]), organised into 11 chapters. During the 11-week intervention phase, parents were asked to read one of the chapters each week, which they then discussed in weekly phone calls that aimed to enhance parents' motivation **Control**: Waitlist	3, 65, 74	26	22	Externalising and internalising child problem behaviour Dysfunctional parenting practices Parent depression, anxiety stress	0.92 0.16 0.44
Morawska and Sanders[68] (2006a)	Mothers of toddlers	**Intervention group:** Received the 'Every Parent's Self-Help Workbook' (Markie-Dadds, Sanders, and Turner[76]), as well as tip sheets on various toddler behaviours (Turner, Markie-Dadds, and Sanders[77]) and the 'Every Parent's Survival Guide' video (Sanders, Markie-Dadds, and Turner[78]). Each week for a period of 10 weeks, mothers were expected to read material and complete a series of workbook tasks. They also received weekly telephone consultations. The weekly telephone consultations were initiated by the clinician and were used to support parents' own problem-solving skills	3, 65	43	42	Child behaviour: - ECBI intensity - ECBI problem Toddler care questionnaire TCQ Parental style: - Parental scale PS, - Parental anger inventory PAI) Parental adjustment: - Depression - Anxiety - Stress	 0.12 0.36 0.89 0.01 0.12 0.21 0.16 0.03
Morawska and Sanders[69] (2006b)	Mothers of toddlers	Same as Morawska and Sanders[68] (2006a), above	3, 65, 74	110		Child behaviour: - ECBI intensity - ECBI problem Toddler care questionnaire TCQ Parental style: - Parental scale PS,	 0.63 0.95 0.76 0.81

						- Parental anger inventory PAI) Parental adjustment: - Depression - Anxiety - Stress	0.66 0.34 0.06 0.65

Notes: Behaviour Change Technique: BCT Taxonomy (v1) for interpretation of BCT numbers. ECBI: Eyberg Child Behavior Inventory. Effect size, colour coded: small effect size, medium effect size, large effect size.

Results of the effects of interventions providing antenatal and postnatal support

Four studies provided evidence on the effectiveness of telephone-delivered interventions designed to support pregnant mothers. Three studies found that such interventions were more effective than control interventions[61, 63, 64], while a fourth found that a telephone-delivered intervention was not as effective as an intervention delivered face-to-face.[62] Nine BCTs were used in these four studies. Social support (either unspecified, social or practical) and problem solving featured in all four studies, while two studies provided a credible source of information. The present studies therefore provide tentative support for the use of these BCTs for supporting parents. In addition, while verbal persuasion about capability was only used in one study, it appears to result in a very large effect size on maternal and infant sleep outcomes.

Results of interventions providing support to parents of infants and toddlers

The evidence reviewed in Table 6 suggests that relatively simple telephone-delivered (or telephone-supported) interventions can result in significant improvements in both children's behaviour and parent's wellbeing (e.g. Gallart and Matthey[70], Kierfeld et al.[67], Morawska and Sanders[68, 69]). Huebner and Meltzoff[66] also found no significant difference in the reading style of parents who received a telephone-delivered intervention designed to support this behaviour, a face-to-face intervention, or written material, suggesting that in this domain telephone-supported interventions are as effective as other modes of intervention delivery. While based on relatively few studies, there was some evidence to suggest that providing helpful and reliable information, prompting problem solving and providing social support were effective BCTs in addressing children's behaviour and parents' wellbeing. Morawska and Sanders[68, 69] also demonstrated that such interventions have the potential for longer lasing effects. Interestingly, three of the four studies that we identified used the Triple-P program, and all found it to be effective. While Gallart and Matthey[70] found no additional benefit from the telephone component of the intervention, Morawska and Sanders[68] found significant differences between the parents who did and those who did not receive telephone support, and this difference remained at the six-month follow-up. In addition, Morawska and Sanders[68] suggest that satisfaction with the program was higher when telephone support was provided. Taken together, these studies suggest that the inclusion of telephone-delivered intervention components within the Triple-P program is worthwhile.

The evidence with regards to the effect of telephone-delivered interventions for supporting the parents of infants (under 12 months old) is inconclusive with regards to which BCTs are effective. Only one study (Hall et al.[65]) targeted parents of infants aged 6–12 months, in order to improve parents' sleep quality, fatigue, depressive mood, marital relationships and cognitions about infant sleep. The intervention included social support (unspecified), self-monitoring of the outcomes of behaviour, information about antecedents, problem solving and information from a credible source. While the intervention was effective, it was not possible to determine the effectiveness of the different intervention delivery methods that were used in the study (i.e. telephone and face-to-face), nor was it possible to determine the relative effectiveness of the different BCTs because these were not manipulated in isolation.

Question 3: What tools can be used to make a decision about which BCTs should be employed and when?

None of the studies included in the review reported using specific tools to determine which BCTs should be employed and when. However, some studies reported using theory to help to identify the determinants of behaviour and to select BCTs. For example, Liu et al.'s[49] intervention was based on social cognitive theory[4] and aimed to prevent excessive weight gain during pregnancy and to promote weight loss after delivery. In addition, interventions targeting weight loss often included BCTs derived from control theory, even if the studies did not explicitly refer to the use of control theory. In contrast, interventions designed to support parents typically did not employ these BCTs derived from control theory. We identified only one study that required parents to self-monitor their behaviour (Hall et al.[65] prompted participants to use sleep charts to record their sleep).

5 Discussion

The effect of telephone-delivered interventions targeting healthy weight

On average, telephone-delivered interventions targeting healthy weight had small-sized positive effects on physical activity (d_+ = 0.21), and medium-sized positive effects on diet (d_+ = 0.54). These findings support the conclusions of previous reviews that have found telephone-delivered interventions addressing weight loss to be effective in promoting changes in associated behaviours (e.g. Eakin et al.[6]). We also investigated which factors influence the effectiveness of these interventions.

The age of participants did not influence the effectiveness of interventions. However, we only identified three studies where the mean age of participants was 20 or under,[39, 44, 55] suggesting that more research is required to identify whether there are specific issues related to promoting healthy weight among this population.

Some insights into the effectiveness of health interventions targeting physical activity, nutrition and healthy weight among university and college students are provided by a recent review by Plotnikoff et al.[79], although the review did not consider the mode of delivery. Searching the literature since 1970, they identified 41 interventions that focused on helping young adults to manage their weight. The findings were promising, with at least half of the studies reporting significant effects of the interventions on physical activity and nutrition. However, Plotnikoff et al.[79] report that interventions targeting nutrition only resulted in more significant outcomes in comparison to interventions that targeted physical activity, weight in general or multiple behaviours. Plotnikoff et al.[79] further identified that interventions that were embedded within university/college courses were more effective at improving physical activity, nutrition and weight-related outcomes when compared to those that were not embedded. Interestingly, shorter interventions spanning a university semester or less (≤ 12 weeks) generally resulted in a greater number of significant outcomes in comparison to longer interventions with a duration of more than a semester. Lastly, interventions where students received feedback on their progress appeared to be more effective than simply attending lectures or receiving educational resources. Unfortunately, Plotnikoff et al.'s[79] review did not include any consideration to the mode of delivery or the specific BCTs employed by the interventions. This is therefore a priority for future research.

Whether participants were recruited or self-referred to the intervention did not influence the effectiveness of interventions that we reviewed on behaviour change. However, because only a relatively small number of studies allowed participants to self-refer (k = 2), further studies are needed. Many telephone-delivered interventions combined this mode of delivery with other methods, such as the provision of printed materials or face-to-face contact. However, only the addition of internet-delivered components was associated with larger effects on behaviour. This finding is consistent with reviews of internet-delivered interventions that report positive effects on (health) behaviour (e.g. Webb et al.[23]) and evidence that suggests that combining internet-delivered interventions with telephone support improves engagement and lowers attrition.[80]

The interventions employed 26 different BCTs. The BCTs that were associated with the largest effect sizes included:

1. Behaviour substitution
2. The creation of a behavioural contract
3. Providing information from a credible source.

However, only a small number of interventions employed these techniques, so the findings should be treated with caution and form the basis for future investigation. There were, however, a number of BCTs that were examined in 10 or more studies that were associated with at least small-sized effects on behaviour. These included:

1. Providing instruction on how to perform a behaviour
2. Prompting or encouraging self-monitoring of behaviour
3. Goal setting (behaviour or outcome)
4. Social support (unspecified)
5. Reviewing behaviour goal(s)
6. Problem solving
7. Action planning.

We would therefore advocate the use of these BCTs in future telephone-delivered interventions targeting weight loss. We would also note that reviews in other domains have found that specific combinations of BCTs (e.g. those specified by control theory[2], such as goal setting, reviewing and monitoring) are particularly effective in promoting, for example, healthy eating and physical activity.[81, 82] As such, theory may provide a useful way to select effective combinations of BCTs.

The effects of interventions providing antenatal and postnatal support

Given the relative paucity of the evidence to date, further studies are needed to investigate the effect of telephone-delivered interventions for supporting pregnant women. Although the results of the studies we reviewed here suggest that telephone delivered intervention can be effective for providing antenatal and postnatal support, we suggest that studies should investigate the effect of telephone support with or without additional intervention components (e.g. face-to-face contact, written information). In addition, future studies designed to support pregnant women might usefully investigate the most suitable time to deliver the intervention (i.e. how long before and after birth should the intervention begin and end), and the possibility that certain groups of participants (e.g. teenage mothers or those from low-socio economic backgrounds) may be particularly vulnerable and so need additional and/or different support.[61]

Interventions providing support to parents of infants and toddlers

As with the review of interventions providing support to pregnant women, the evidence-base for the effectiveness of telephone-delivered interventions designed to support the parents of young children is sparse, and more research is needed. While results suggest that relatively simple interventions can be effective in addressing parents' wellbeing and children's behavioural problems and cognitive development, we suggest that future research should (i) include larger samples (the largest sample we have reviewed involved 110 parents[69]), (ii) investigate the effectiveness of telephone-delivered interventions targeting a larger range of outcomes, for example, toilet training or different measures of parental wellbeing, (iii)

identify the active ingredients of interventions (e.g. by systematically manipulating specific BCTs, such as providing identical intervention with or without social support, goal setting etc.), and (iv) assess the long-term effects of interventions.

The evidence with respect to the tools used to assist decision-making regarding which BCT should be employed, and when

None of the studies reported using specific tools to determine which BCT(s) should be employed and when, although some studies reported using theory to help to identify the determinants of behaviour that might be targeted by interventions and to select specific BCTs to target these determinants. Previous research has shown that using theory increases the efficacy of interventions (for a review, see Prestwich et al.[22]) and there is evidence that theory can be used to identify 'combinations' of BCTs that are particularly effective. For example, Michie et al.[81] found that interventions that combined self-monitoring with at least one other BCT derived from Carver and Scheier's[2] control theory (e.g. goal setting, action planning) were more effective in promoting fruit and vegetable intake than interventions that did not incorporate these additional BCTs.

In the present review, however, while interventions targeting weight loss often included BCTs derived from control theory, interventions designed to support parents did not often employ these BCTs. Indeed, we identified only one study that required parents to self-monitor their behaviour.[65] Interventions designed to support parents were more likely to employ BCTs involving the provision of practical and emotional social support, and to provide parents with a credible source of information. However, it is important to consider the target behaviour when selecting BCTs. To state the obvious, it may be that providing social support helps pregnant women to cope with their situation, but other techniques are more effective in promoting fruit and vegetable consumption among teenagers.

Given that none of the telephone-delivered interventions reviewed here reported using specific tools to determine which BCT(s) should be employed and when, and relatively few explicitly used theory to assist decision making, we suggest that such interventions may not yet fulfil their potential. We further suggest that telephone-delivered interventions targeting weight loss could, in addition to including BCTs that address components of Control Theory, benefit from providing more specific social support, such as providing information on local parks and walking groups, or providing emotional support to help individuals cope with personal difficulties (e.g. shame). Interventions addressing weight loss may also benefit from providing individuals with reliable information about healthy diets and the consequences of their behaviour. For example, Liu et al.[49], who based their intervention on social cognitive theory[4], encouraged participants to seek social support and provided them with reliable information about healthy lifestyle guidance. The effect of their intervention on physical activity was among the larger of the studies reviewed (d_+ = 0.44).

With regards to interventions designed to support parents, there is a need to identify whether there are theories that can help to select effective (combinations of) BCTs. Such theory may provide a rationale for setting and monitoring goals. For example, when targeting sleep patterns, or incidents of disruptive behaviours, it could be useful to keep a chart or a diary of the pattern and amount of sleep, or incidents and times of disruptive behaviour, in order to learn from these patterns and to help parents see improvements. While we only identified one study using a sleep chart[65], the effect size on sleep quality in this study was large (d_+ = 1.05).

6 Conclusion

The current review examined the effectiveness of telephone-delivered or supported interventions targeting weight loss and providing support for pregnant women and the parents of young children.

Question 1

Meta-analysis revealed that telephone-delivered interventions targeting weight gain had small-sized effects on diet, and medium-sized effects on physical activity. We also identified several BCTs that were both commonly used and effective. These included providing instruction on how to perform a behaviour, prompting or encouraging self-monitoring, goal setting and reviewing, social support, problem solving and action planning. Several of these BCTs target components of Control Theory and thus provide support for the use of theory to inform the design of interventions.

Question 2

A narrative review of telephone-delivered interventions designed to support parents suggested that such interventions can be effective in promoting changes in behaviour. Common BCTs in these studies included social support, problem solving and providing a credible source of information. However, the evidence-base was limited and so no clear conclusions were drawn concerning which BCTs were effective.

Question 3

The use of tools to aid the choice of BCTs was sparse, although some studies used theory to select BCTs. There is, therefore, a clear need for future research to consider the use of theory, and in particular Control Theory, as a tool for selecting (combinations of) BCTs that are effective in promoting changes in behaviour in more detail. The use of theory in this way has proved effective in other domains (see, for example, Dombrowski et al.[82], Michie et al.[81]).

7 References

1. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Annals Behavioral Medicine. 2013;46(1):81-95.

2. Carver CS, Scheier MF. Control theory: a useful conceptual framework for personality-social, clinical, and health psychology. Psychological Bulletin. 1982;92(1):111-35.

3. Ajzen I. Theories of Cognitive Self-RegulationThe theory of planned behavior. Organizational Behavior and Human Decision Processes. 1991;50(2):179-211.

4. Bandura A. Social foundations of thought and action: A social cognitive theory: Prentice-Hall, Inc; 1986.

5. Sanders MR, Markie-Dadds C. Triple P: A multilevel family intervention program for children with disruptive behaviour disorders. In: Jackson PCH, editor. Early Intervention and Prevention in Mental Health. Melbourne, Victoria: Australian Psychological Society; 1996. p. 59-85.

6. Eakin EG, Lawler SP, Vandelanotte C, Owen N. Telephone interventions for physical activity and dietary behavior change: a systematic review. American Journal of Preventative Medicine. 2007;32(5):419-34.

7. Goode AD, Reeves MM, Eakin EG. Telephone-delivered interventions for physical activity and dietary behavior change: an updated systematic review. American Journal of Preventative Medicine. 2012;42(1):81-8.

8. Eriksson KF, Lindgarde F. Prevention of type 2 (non-insulin-dependent) diabetes mellitus by diet and physical exercise. The 6-year Malmo feasibility study. Diabetologia. 1991;34(12):891-8.

9. Wiseman M. The Second World Cancer Research Fund/American Institute for Cancer Research Expert Report. Food, Nutrition, Physical Activity, and the Prevention of Cancer: A Global Perspective. Proceedings of the Nutrition Society. 2008;67(03):253-6.

10. Kahn EB, Ramsey LT, Brownson RC, Heath GW, Howze EH, Powell KE, et al. The effectiveness of interventions to increase physical activity. A systematic review. American Journal of Preventative Medicine. 2002;22(4 Suppl):73-107.

11. Graves N, Barnett AG, Halton KA, Veerman JL, Winkler E, Owen N, et al. Cost-effectiveness of a telephone-delivered intervention for physical activity and diet. PloS one. 2009;4(9):e7135.

12. Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, et al. High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children. Preventative Medicine. 2008;47(1):77-82.

13. Sanders MR, Ralph A, Sofronoff K, Gardiner P, Thompson R, Dwyer S, et al. Every family: a population approach to reducing behavioral and emotional problems in children making the transition to school. The Journal of Primary Prevention. 2008;29(3):197-222.

14. Klohe-Lehman DM, Freeland-Graves J, Clarke KK, Cai G, Voruganti VS, Milani TJ, et al. Low-income, overweight and obese mothers as agents of change to improve food choices, fat habits, and physical activity in their 1-to-3-year-old children. Journal of the American College of Nutrition. 2007;26(3):196-208.

15. Havas S, Anliker J, Damron D, Langenberg P, Ballesteros M, Feldman R. Final results of the Maryland WIC 5-A-Day Promotion Program. American Journal of Public Health. 1998;88(8):1161-7.

16. Wyse R, Wolfenden L, Campbell E, Campbell KJ, Wiggers J, Brennan L, et al. A cluster randomized controlled trial of a telephone-based parent intervention to increase preschoolers' fruit and vegetable consumption. The American Journal of Clinical Nutrition. 2012;96(1):102-10.

17. Lewis C, Packman A, Onslow M, Simpson JM, Jones M. A phase II trial of telehealth delivery of the Lidcombe Program of Early Stuttering Intervention. American Journal of Speech-Language Pathology. 2008;17(2):139-49.

18. Giarelli E, Souders M, Pinto-Martin J, Bloch J, Levy SE. Intervention pilot for parents of children with autistic spectrum disorder. Pediatric Nursing. 2005;31(5):389-99.

19. Dennis CL, Kingston D. A systematic review of telephone support for women during pregnancy and the early postpartum period. Journal of Obstetric, Gynecologic, and Neonatal Nursing: JOGNN / NAACOG. 2008;37(3):301-14.

20. Michie S, Atkins L, West R. The behavior change wheel: A guide to designing interventions. Surrey, UK: Silverback Publishing; 2015. 329 p.

21. Sniehotta FF, Presseau J, Araújo-Soares V. Time to retire the theory of planned behaviour. Health Psychology Review. 2014;8(1):1-7.

22. Prestwich A, Webb TL, Conner M. Using theory to develop and test interventions to promote changes in health behaviour: evidence, issues, and recommendations. Current Opinion in Psychology. 2015;5:1-5.

23. Webb TL, Joseph J, Yardley L, Michie S. Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. Journal of Medical Internet Research. 2010;12(1):e4.

24. Burton E, Butler G, Hodgkinson J, Marshall S. Quick but not dirty: rapid evidence assessments (REAs) as a decision support tool in social policy. In: E Hogard REJW, editor. Community safety: Innovation and evaluation. Chester: Chester Academic Press; 2007.

25. Hailey D, Corabian P, Harstall C, Schneider W. The use and impact of rapid health technology assessments. International Journal of Technology Assessments in Health Care. 2000;16(2):651-6.

26. Khangura S, Konnyu K, Cushman R, Grimshaw J, Moher D. Evidence summaries: the evolution of a rapid review approach. Systematic Reviews. 2012;1:10.

27. Betzold CM, Laughlin KM, Shi C. A family practice breastfeeding education pilot program: an observational, descriptive study. International Breastfeeding Journal. 2007;2(1):1-6.

28. Abildso C, Zizzi S, Gilleland D, Thomas J, Bonner D. A Mixed Methods Evaluation of a 12-Week Insurance-Sponsored Weight Management Program Incorporating Cognitive-Behavioral Counseling. Journal of Mixed Methods Research. 2010;4(4):278-94.

29. Albright CL, Maddock JE, Nigg CR. Increasing physical activity in postpartum multiethnic women in Hawaii: results from a pilot study. BMC Women's Health. 2009;9:4.

30. Pierce JP, James LE, Messer K, Myers MG, Williams RE, Trinidad DR. Telephone counseling to implement best parenting practices to prevent adolescent problem behaviors. Contemporary Clinical Trials. 2008;29(3):324-34.

31. Anderson DR, Christison-Lagay J, Villagra V, Liu H, Dziura J. Managing the space between visits: a randomized trial of disease management for diabetes in a community health center. Journal of General Internal Medicine. 2010;25(10):1116-22.

32. Dennison L, Morrison L, Lloyd S, Phillips D, Stuart B, Williams S, et al. Does brief telephone support improve engagement with a web-based weight management intervention? Randomized controlled trial. Journal of Medical Internet Research. 2014;16(3):e95.

33. Jakicic JM, Marcus BH, Lang W, Janney C. Effect of exercise on 24-month weight loss maintenance in overweight women. Archives of Internal Medicine. 2008;168(14):1550-9; discussion 9-60.

34. Paineau DL, Beaufils F, Boulier A, Cassuto DA, Chwalow J, Combris P, et al. Family dietary coaching to improve nutritional intakes and body weight control: a randomized controlled trial. Archives of Pediatrics & Adolescent Medicine. 2008;162(1):34-43.

35. Simpson SA, McNamara R, Shaw C, Kelson M, Moriarty Y, Randell E, et al. A feasibility randomised controlled trial of a motivational interviewing-based intervention for weight loss maintenance in adults. Assessment HT, editor. Southhampton, UK: NIHR Journals Library; 2015.

36. Cohen J. A power primer. Psychological Bulletin. 1992;112(1):155-9.

37. Wilson DB. SPSS macros for meta-analytic data 2005 [21 October 2015]. Available from: http://mason.gmu.edu/~dwilsonb/ma.html.

38. Boutelle KN, Dubbert P, Vander Weg M. A pilot study evaluating a minimal contact telephone and mail weight management intervention for primary care patients. Eating and Weight Disorders – Studies on Anorexia, Bulimia and Obesity. 2005;10(1):e1-e5.

39. Buscemi J, Yurasek AM, Dennhardt AA, Martens MP, Murphy JG. A randomized trial of a brief intervention for obesity in college students. Clinical Obesity. 2011;1(4-6):131-40.

40. Carpenter KM, Lovejoy JC, Lange JM, Hapgood JE, Zbikowski SM. Outcomes and utilization of a low intensity workplace weight loss program. Journal of Obesity. 2014.

41. Damschroder LJ, Lutes LD, Goodrich DE, Gillon L, Lowery JC. A small-change approach delivered via telephone promotes weight loss in veterans: results from the ASPIRE-VA pilot study. Patient Education and Counselling. 2010;79(2):262-6.

42. Damschroder LJ, Lutes LD, Kirsh S, Kim HM, Gillon L, Holleman RG, et al. Small-changes obesity treatment among veterans: 12-month outcomes. American Journal of Preventative Medicine. 2014;47(5):541-53.

43. Dawes D, Ashe M, Campbell K, Cave D, Elley CR, Kaczorowski J, et al. Preventing diabetes in primary care: a feasibility cluster randomized trial. Canadian Journal of Diabetes. 2015;39(2):111-6.

44. Deforche B, De Bourdeaudhuij I, Tanghe A, Debode P, Hills AP, Bouckaert J. Post-treatment phone contact: a weight maintenance strategy in obese youngsters. International Journal of Obesity. 2005;29(5):543-6.

45. Dekkers JC, van Wier MF, Ariens GA, Hendriksen IJ, Pronk NP, Smid T, et al. Comparative effectiveness of lifestyle interventions on cardiovascular risk factors among a Dutch overweight working population: a randomized controlled trial. BMC Public Health. 2011;11(1):49.

46. Gerber BS, Schiffer L, Brown AA, Berbaum ML, Rimmer JH, Braunschweig CL, et al. Video telehealth for weight maintenance of African-American women. Journal of Telemedicine and Telecare. 2013;19(5):266-72.

47. Groeneveld IF, Proper KI, van der Beek AJ, van Mechelen W. Sustained body weight reduction by an individual-based lifestyle intervention for workers in the construction industry at risk for cardiovascular disease: results of a randomized controlled trial. Preventative Medicine. 2010;51(3-4):240-6.

48. Kim Y, Pike J, Adams H, Cross D, Doyle C, Foreyt J. Telephone intervention promoting weight-related health behaviors. Preventative Medicine. 2010;50(3):112-7.

49. Liu J, Wilcox S, Whitaker K, Blake C, Addy C. Preventing excessive weight gain during pregnancy and promoting postpartum weight loss: a pilot lifestyle intervention for overweight and obese African American women. Maternal and Child Health Journal. 2015;19(4):840-9.

50. Lutes LD, Daiss SR, Barger SD, Read M, Steinbaugh E, Winett RA. Small changes approach promotes initial and continued weight loss with a phone-based follow-up: nine-month outcomes from ASPIRES II. American Journal of Health Promotion. 2012;26(4):235-8.

51. Newman VA, Flatt SW, Pierce JP. Telephone counseling promotes dietary change in healthy adults: results of a pilot trial. Journal of the American Dietetic Association. 2008;108(8):1350-4.

52. O'Hara BJ, Phongsavan P, Venugopal K, Eakin EG, Eggins D, Caterson H, et al. Effectiveness of Australia's Get Healthy Information and Coaching Service®: translational research with population wide impact. Preventive Medicine. 2012;55(4):292-8.

53. O'Hara BJ, Phongsavan P, Eakin EG, Develin E, Smith J, Greenaway M, et al. Effectiveness of Australia's Get Healthy Information and Coaching Service®: maintenance of self-reported anthropometric and behavioural changes after program completion. BMC Public Health. 2013;13:175.

54. Partridge SR, McGeechan K. Effectiveness of a mHealth Lifestyle Program With Telephone Support (TXT2BFiT) to Prevent Unhealthy Weight Gain in Young Adults: Randomized Controlled Trial. JMIR mHealth and uHealth. 2015;3(2):e66.

55. Pearson ES, Irwin JD, Morrow D, Battram DS, Melling CW. The CHANGE program: comparing an interactive vs. prescriptive approach to self-management among university students with obesity. Canadian Journal of Diabetes. 2013;37(1):4-11.

56. Sangster J, Furber S, Allman-Farinelli M, Phongsavan P, Redfern J, Haas M, et al. Effectiveness of a pedometer-based telephone coaching program on weight and physical activity for people referred to a cardiac rehabilitation program: a randomized controlled trial. Journal of Cardiopulmonary Rehabilitation and Prevention. 2015;35(2):124-9.

57. Smith BK, Van Walleghen EL, Cook-Wiens G, Martin RN, Curry CR, Sullivan DK, et al. Comparison of two self-directed weight loss interventions: Limited weekly support vs. no outside support. Obesity Research and Clinical Practice. 2009;3(3):149-57.

58. Ströbl V, Knisel W, Landgraf U, Faller H. A Combined Planning and Telephone Aftercare Intervention for Obese Patients: Effects on Physical Activity and Body Weight After One Year. Journal of Rehabilitation Medicine. 2013;45(2):198-205.

59. van Wier MF, Dekkers JC, Hendriksen IJ, Heymans MW, Ariëns GA, Pronk NP, et al. Effectiveness of phone and e-mail lifestyle counseling for long term weight control among overweight employees. Journal of Occupational and Environmental Medicine. 2011;53(6):680-6.

60. van Wier MF, Ariens GA, Dekkers JC, Hendriksen IJ, Smid T, van Mechelen W. Phone and e-mail counselling are effective for weight management in an overweight working population: a randomized controlled trial. BMC Public Health. 2009;9:6.

61. Collado O, Assumpta M, Saez M, Favrod J, Hatem M. Antenatal psychosomatic programming to reduce postpartum depression risk and improve childbirth outcomes: a randomized controlled trial in Spain and France. BMC Pregnancy and Childbirth. 2014;14(1):1-12.

62. Guttentag CL, Landry SH, Williams JM, Baggett KM, Noria CW, Borkowski JG, et al. "My Baby & Me": effects of an early, comprehensive parenting intervention on at-risk mothers and their children. Developmental Psychology. 2014;50(5):1482-96.

63. Milgrom J, Schembri C, Ericksen J, Ross J, Gemmill AW. Towards parenthood: an antenatal intervention to reduce depression, anxiety and parenting difficulties. Journal of Affective Disorders. 2011;130(3):385-94.

64. Stremler R, Hodnett E, Lee K, MacMillan S, Mill C, Ongcangco L, et al. A behavioral-educational intervention to promote maternal and infant sleep: a pilot randomized, controlled trial. Sleep. 2006;29(12):1609-15.

65. Hall WA, Clauson M, Carty EM, Janssen PA, Saunders RA. Effects on parents of an intervention to resolve infant behavioral sleep problems. Pediatric Nursing. 2006;32(3):243-50.

66. Huebner CE, Meltzoff AN. Intervention to change parent–child reading style: A comparison of instructional methods. Journal of Applied Developmental Psychology. 2005;26(3):296-313.

67. Kierfeld F, Ise E, Hanisch C, Gortz-Dorten A, Dopfner M. Effectiveness of telephone-assisted parent-administered behavioural family intervention for preschool children with externalizing problem behaviour: a randomized controlled trial. European Child & Adolescent Psychiatry. 2013;22(9):553-65.

68. Morawska A, Sanders MR. Self-administered behavioral family intervention for parents of toddlers: Part I. Efficacy. Journal of Consulting and Clinical Psychology. 2006;74(1):10-9.

69. Morawska A, Sanders MR. Self-administered behavioural family intervention for parents of toddlers: effectiveness and dissemination. Behaviour Research and Therapy. 2006;44(12):1839-48.

70. Gallart SC, Matthey S. The Effectiveness of Group Triple P and the Impact of the Four Telephone Contacts. Behaviour Change. 2005;22(02):71-80.

71. Landry SH, Smith KE, Swank PR. Responsive parenting: establishing early foundations for social, communication, and independent problem-solving skills. Developmental Psychology. 2006;42(4):627-42.

72. Milgrom J, Ericksen J, Leigh B, Romeo Y, Loughlin E, McCarthy R, et al. Towards Parenthood: Preparing for the changes and challenges of a new baby. Camberwell: ACER Press; 2009.

73. Whitehurst GJ, Falco FL, Lonigan CJ, Fischel JE, DeBaryshe BD, Valdez-Menchaca MC, et al. Accelerating language development through picture book reading. Developmental Psychology. 1988;24:552-9.

74. Huebner CE. Hear and say reading with toddlers [Instructional video]. Bainbridge Island WA7: Bainbridge Island Rotary; 2001.

75. Dopfner M, Schurmann S, Lehmkuhl G. Wackelpeter & Trotzkopf. Hilfen fur Eltern bei ADHS-Symptomen, hyperkineti- schem und oppositionellem Verhalten (Help for parents with ADHD symptoms). 4th ed. Weinheim: Beltz; 2011.

76. Markie-Dadds C, Sanders MR, Turner KMT. Every parent's self-help workbook. Milton, Australia: Families International; 1999.

77. Turner KMT, Markie-Dadds C, Sanders MR. Triple P tip sheet series for toddlers. Brisbane, Australia: Families International; 1996.

78. Sanders MR, Markie-Dadds C, Turner KMT. Every parent's survival guide [Video]. Brisbane, Australia: Families International; 1996.

79. Plotnikoff RC, Costigan SA, Williams RL, Hutchesson MJ, Kennedy SG, Robards SL, et al. Effectiveness of interventions targeting physical activity, nutrition and healthy weight for university and college students: a systematic review and meta-analysis. The International Journal of Behavioral Nutrition and Physical Activity. 2015;12:45.

80. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which Intervention Characteristics are Related to More Exposure to Internet-Delivered Healthy Lifestyle Promotion Interventions? A Systematic Review. Journal of Medical Internet Research. 2011;13(1):e2.

81. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychology. 2009;28(6):690-701.

82. Dombrowski SU, Sniehotta FF, Avenell A, Johnston M, MacLennan G, Araújo-Soares V. Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: A systematic review. Health Psychology Review. 2012;6:7-32.

8 Appendices

Appendix 1: Review of mHealth interventions for healthy weight and parenting support

In 2012, there were more than 6 billion mobile phone subscribers and 75% of the world had access to a mobile phone.[1] These figures are undoubtedly larger nowadays, prompting service and care providers, researchers and national governments to develop mobile health (mHealth) solutions to improve access to health care, engagement and delivery, and health outcomes.[2] The current review briefly summarises the existing evidence on mHealth interventions for i) healthy weight and ii) parenting support drawing on the definition of mHealth provided by Nurmatov et al.[3]: *"It may be thought of as involving various 'devices' such as mobile phones and smartphones, personal digital assistants, tablet computers, laptops and digital point-of-care testing devices, 'delivery modes' such as voice, text, images or video, and 'applications' such as public health messaging, personalised behaviour change interventions, workflow management, health surveillance, access to patient records, clinical decision support, education, diagnostics and remote care provision…the term mHealth is reserved exclusively for mobile and wireless digital tools and interventions"*.[3(p2)]

1. mHealth interventions targeting healthy weight

The use of mobile technologies as a mode of delivery to help people to lose weight is a rapidly growing area. The summary below captures early insights into the findings so far and we summarise a range of conclusions and make recommendations to develop the evidence base.

Range of devices, delivery modes and applications.

A number of reviews have evaluated the use of communication via mobile phones. Bert et al.[4] argue that the latest generation of smartphones are comparable to computers, allowing the development of new applications in the health field. In the field of nutrition there are a range of novel and engaging intervention strategies used by smartphones; and users report that they find them both useful and viable for promoting behaviour change.[5] While Bert et al.[4] do not specifically focus on particular BCTs or theory, they report that applications can enable activities such as calorie counting or maintaining a food diary, which readily map to monitoring outcomes and behaviours.

In relation to physical activity, applications tend to suggest exercises and measure sports statistics. However, Bort-Roig et al.[4] reported that smartphone strategies to influence physical activity tended to be ad hoc, rather than theory-based. In addition, they found that physical activity profiles, goal setting, real-time feedback, social support networking and online expert consultation were the most useful strategies to encourage physical activity change.

Effectiveness of mHealth interventions targeting healthy weight

There is strong evidence that mHealth interventions are associated with weight loss and maintenance of weight loss among obese children[6] and adults.[7] In overweight and obese adults, interventions using mobile technology facilitate weight loss in the short term, with moderate evidence for medium-term loss.[7] Other reviews reported 'promising' relationships between the use of text messaging and weight loss through increases in physical activity, reductions in sedentary behaviour or improvements in dietary habits.[8]

Effective BCTs in mHealth interventions

Khaylis et al.[9] identified five techniques used by technology-based interventions (including mHealth interventions) for weight loss that were associated with successful interventions. Components of programs that were effective in maintaining weight loss were: i) self-monitoring (BCT 10, 11), ii) feedback and communication (e.g. from a counsellor, BCT 8, 9), iii) social support (BCT 1, 2, 3), and iv) use of a structured individually tailored program (BCT 68). Pagoto et al.[10] however, found that mobile apps targeting weight loss typically included only a minority of the behavioural strategies found in evidence-based weight-loss interventions, and some did not contain any evidence-based strategies. For example, most applications did not include strategies to improve motivation, reduce stress (both could be achieved by social support), or assist with problem solving (BCT 65). The most common technology-enhanced features were found to be barcode scanners and the provision of, or facilitating access to, a social network (i.e. the capability to either connect to other app users or post to an online social network, such as Facebook, Twitter, or one created by the company itself). Bort-Roig et al.[5] reported that in studies conducted in highly economically advantaged countries, physical activity profiles, goal setting, real-time feedback, social support networking and online expert consultation were the most useful strategies to encourage physical activity change. Finally, an interesting review by Brouwer et al.[11] identified the characteristics of internet-delivered interventions that may be related to greater exposure to the intervention and found that peer and counsellor support resulted in a longer website visits; and that email/phone contact resulted in more log-ins.

Conclusions and recommendations

1. Short term results of technology-based interventions for weight loss are promising[9] and suggest that mHealth could be a helpful tool
2. There is moderate evidence that mHealth interventions can promote weight loss in the medium-term[7]
3. The interface of technology-driven weight loss and behaviour change may form the basis for long-term weight loss.[9] However, more research is needed on long term outcomes[7, 9]
4. Further investigation is needed to better explore the intervention capabilities of smartphones including fully powered RCTs, larger sample sizes, longitudinal trials, evaluating cost-effectiveness, frequency, time and optimal use of text messaging, and detailed and quality reporting of outcomes[5, 8]
5. The reporting and quality of studies needs to be improved. Studies need to explore how acceptable technology such as that used in mHealth interventions is, as this will likely influence uptake and use[7]
6. The strategies used in mHealth interventions should be evidence-based and have theoretical underpinnings[5, 10]
7. The diversity of intervention methods used and inconsistent reporting of exposure to internet-delivered interventions prevent firm conclusions from being made about the characteristics of interventions that may enhance success. More research is needed to identify which characteristics of internet interventions are associated with greater exposure.[11]

2. mHealth interventions designed to support parents

We identified just two very recent reviews in this area, each of which only examined the efficacy of text messaging. The evidence base for mHealth interventions in this field is, therefore, somewhat lacking. Nurmatov et al.[3] outlined a protocol for a systematic review and meta-analysis on the effectiveness of mHealth interventions for maternal, newborn and child health in low-and middle-income countries. Poorman et al.[12] conducted a systematic review on the use of text messaging applied to the promotion of maternal and infant health. They found a wide range of preventative behaviours that text message interventions can effectively promote, including smoking cessation, diabetes control, appointment reminders, medication adherence, weight loss and vaccine uptake. It was found that interventions that were based on an established theory of behaviour change and used as motivational as opposed to informational language were more likely to be successful. Poorman et al.[12] conclude that researchers should be able to use this technology to engage difficult-to-reach-populations.

Nurmatov et al.[3] argue that mHealth interventions offer an effective way to overcome economic, geopolitical and sociocultural challenges faced by developing countries, by *"supporting coordinated and evidence-based care, facilitating community-based health services and enabling people to access health care information and support"*.[3(p1)] Nurmatov et al.[3] report that organisations such as mHealth Alliance and USAID are currently conducting mHealth projects in the area of maternal, newborn and child health; however, evidence for a direct impact of mHealth interventions on mortality and morbidity is rare. Evidence for intermediate outcomes, however, is increasing. For example, Song et al.[13] used a two-way text-messaging system to answer the health questions of pregnant low-income women and reported decreased levels of stress and depression, along with improved levels of perceived knowledge about pregnancy-related issues.

Nurmatov et al.[3] are critical of reviews previously conducted in the area (e.g. Philbrick[14]) on the basis that they have not been conducted in a systematic way and the authors imply that the role of the mobile telecommunications industry may inadvertently influence research findings. When published, Nurmatov et al.[3] will be the first to apply rigorous methods for summarising the burgeoning literature in the area. The World Health Organisation (WHO) has called for further evaluation of the role of mHealth in improving patient outcomes and we would echo this call in relation to promoting behaviour change among new parents.

Appendix 2: BCT Taxonomy (v1): 93 hierarchically-clustered techniques

1. Social support (practical)
2. Social support (emotional)
3. Social support (unspecified)
4. Pharmacological support
5. Reduce negative emotions
6. Conserving mental resources
7. Paradoxical instructions
8. Feedback on behaviour
9. Feedback on outcome(s) of behaviour
10. Self-monitoring of behaviour
11. Self-monitoring of outcome(s) of behaviour
12. Monitoring of behaviour by others without feedback
13. Monitoring of outcome(s) of behaviour without feedback
14. Biofeedback
15. Prompts/cues
16. Reduce prompts/cues
17. Cue signalling reward
18. Remove access to the reward
19. Remove aversive stimulus
20. Satiation
21. Exposure
22. Associative learning
23. Behavioural practice/rehearsal
24. Habit formation
25. Behaviour substitution
26. Habit reversal
27. Overcorrection
28. Generalisation of target behaviour
29. Graded tasks
30. Restructuring the physical environment
31. Restructuring the social environment
32. Avoidance/reducing exposure to cues for the behaviour
33. Distraction
34. Adding objects to the environment
35. Body changes
36. Instruction on how to perform a behaviour
37. Information about antecedents
38. Re-attribution
39. Behavioural experiments
40. Verbal persuasion about capability
41. Mental rehearsal of success performance
42. Focus on past success
43. Self-talk
44. Punishment
45. Behaviour cost
46. Remove reward

47. Reward approximation
48. Rewarding completion
49. Situation-specific reward
50. Reward incompatible behaviour
51. Reward alternative behaviour
52. Reduce reward frequency
53. Remove punishment
54. Material incentive (behaviour)
55. Social incentive
56. Non-specific incentive
57. Self-incentive
58. Incentive (outcome)
59. Material reward (behaviour)
60. Social reward
61. Non-specific reward
62. Self-reward
63. Reward (outcome)
64. Future punishment
65. Problem solving
66. Goal setting (behaviour)
67. Goal setting (outcome)
68. Action planning
69. Review behaviour goal(s)
70. Review outcome goal(s)
71. Behavioural contract
72. Commitment
73. Discrepancy between current behaviour and goal
74. Credible source
75. Pros and cons
76. Comparative imagining of future outcomes
77. Identification of self as role model
78. Valued self-identify
79. Framing/reframing
80. Incompatible beliefs
81. Identity associated with changed behaviour
82. Information about health consequences
83. Information about emotional consequences
84. Information about social and environmental consequences
85. Salience of consequences
86. Monitoring of emotional consequences
87. Anticipated regret
88. Demonstration of the behaviour
89. Social comparison
90. Information about others' approval
91. Imaginary punishment
92. Imaginary reward
93. Vicarious consequences.

References

1. ICD. Information and communications for development: maximizing mobile 2012 [1 November 2015]. Available from: www.worldbank.org/ict/IC4D2012.

2. Heerden AV, Tomlinson M, Swartz L. Point of care in your pocket: a research agenda for the field of m-health. Bulletin of the World Health Organization. 2012;90(5):393-4.

3. Nurmatov UB, Lee SH, Nwaru BI, Mukherjee M, Grant L, Pagliari C. The effectiveness of mHealth interventions for maternal, newborn and child health in low– and middle–income countries: Protocol for a systematic review and meta–analysis. Journal of Global Health. 2014;4(1):010407.

4. Bert F, Giacometti M, Gualano MR, Siliquini R. Smartphones and health promotion: a review of the evidence. Journal of medical systems. 2014;38(1):9995.

5. Bort-Roig J, Gilson ND, Puig-Ribera A, Contreras RS, Trost SG. Measuring and influencing physical activity with smartphone technology: a systematic review. Sports Medicine. 2014;44(5):671-86.

6. Smith AJ, Skow A, Bodurtha J, Kinra S. Health information technology in screening and treatment of child obesity: a systematic review. Pediatrics. 2013;131(3):e894-902.

7. Bacigalupo R, Cudd P, Littlewood C, Bissell P, Hawley MS, Buckley Woods H. Interventions employing mobile technology for overweight and obesity: an early systematic review of randomized controlled trials. Obesity Reviews. 2013;14(4):279-91.

8. Shaw R, Bosworth H. Short message service (SMS) text messaging as an intervention medium for weight loss: A literature review. Health Informatics Journal. 2012;18(4):235-50.

9. Khaylis A, Yiaslas T, Bergstrom J, Gore-Felton C. A review of efficacious technology-based weight-loss interventions: five key components. Telemedicine and e-Health. 2010;16(9):931-8.

10. Pagoto S, Schneider K, Jojic M, DeBiasse M, Mann D. Evidence-based strategies in weight-loss mobile apps. American journal of preventive medicine. 2013;45(5):576-82.

11. Brouwer W, Kroeze W, Crutzen R, de Nooijer J, de Vries NK, Brug J, et al. Which Intervention Characteristics are Related to More Exposure to Internet-Delivered Healthy Lifestyle Promotion Interventions? A Systematic Review. Journal of Medical Internet Research. 2011;13(1):e2.

12. Poorman E, Gazmararian J, Parker RM, Yang B, Elon L. Use of text messaging for maternal and infant health: a systematic review of the literature. Maternal and child health journal. 2015;19(5):969-89.

13. Song H, May A, Vaidhyanathan V, Cramer EM, Owais RW, McRoy S. A two-way text-messaging system answering health questions for low-income pregnant women. Patient Education and Counselling. 2013;92(2):182-7.

14. Philbrick WC. mHealth and MNCH: State of the evidence. Trends, gaps, stakeholder needs, and opportunities for future research on the use of mobile technology to improve maternal, newborn, and child health: mHealth Alliance, UN Foundation; 2013 [21 October 2015]. Available from: www.mhealthworkinggroup.org/sites/mhealthwg.org/files/philbrick_mnch_final.pdf.