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Weight loss by mobile phone: a 1-year effectiveness study

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Abstract

Objective: To investigate the short- and long-term effectiveness and the predictors of weight loss in a mobile phone weight-loss programme among healthy overweight adults.

Design: One hundred and twenty-five healthy, overweight (BMI = 26–36 kg/m^2), 25–44-year-old, screened volunteers were randomized to an experimental group (*n* 62) to use a mobile phone-operated weight-loss programme or to a control group (*n* 63) with no intervention. Via text messaging, the programme instructed a staggered reduction of food intake and daily weight reporting with immediate tailored feedback. Assessments were at 0, 3, 6, 9 and 12 months for the experimental group; at 0 and 12 months for the control group. Main outcome variables were changes in body weight and waist circumference.

Results: By 12 months the experimental group had lost significantly more weight than the control group (4·5 (SD 5·0) *v.* 1·1 (SD 5·8) kg; $F(1,80) = 8{\cdot}0$, $P = 0{\cdot}006$) and had a greater reduction in waist circumference (6·3 (SD 5·3) *v.* 2·4 (SD 5·4) cm; $F(1,80) = 55{\cdot}2$, $P = 0{\cdot}0001$). Early weight loss, self-efficacy, contact frequency, attitudes towards the medium, changes in work and family life and changes made in dietary habits were the strongest predictors of weight loss.

Conclusions: This mobile phone weight-loss programme was effective in short- and long-term weight loss. As a minimum-advice, maximal-contact programme, it offers ideas for future weight-loss programmes.

Keywords
Mobile phone
Internet
Contact
Weight maintenance

Interactive communication technology (using the Internet, email and mobile phones) offers an innovative and attractive tool for weight-loss programme delivery. Traditional face-to-face weight-loss programmes are increasingly being enhanced by Internet support[1–3]. Specific mobile phone applications for this purpose are emerging, but the effectiveness of this medium and these new programmes in supporting weight loss have yet to be reported.

Previous research into the effectiveness of Internet-based weight-loss programmes[4–7] has presented short- to medium-term results indicating slightly better performance or no difference when compared with traditional programmes. Many have used email or telephone to support a web-based programme with weekly assignments. They have mostly been labour-intensive, requiring considerable counselling input from health-care professionals. In the current study we investigated the effectiveness of a programme providing minimal advice and no counselling but a maximum possibility for user-initiated contact and connectedness via text messaging.

Effective weight-loss programmes must support dieters in the process of learning and adopting new dietary and physical activity behaviours[8,9]. A theoretical model[10] to guide research into educational/behavioural interventions utilizing new, interactive media suggests that the amount, frequency and type of use of the programme (contact) influences learning effectiveness. This model, combined with Bandura's[11] self-efficacy theory, suggests that attitudes to teletechnology and perceptions of personal self-efficacy in dieting will influence contact and the use made of the programme and thereby may affect weight loss. External life-events and circumstances would exert an additional influence. Guided by the theoretical model presented in Fig. 1, we examined the possible influence on weight loss exerted by selected background characteristics (exogenous variables), process variables and contact with the programme. The current paper reports short-term (3-month) and long-term (12 months) results from a 1-year study into the effectiveness of a mobile phone weight-loss programme among healthy overweight adults.

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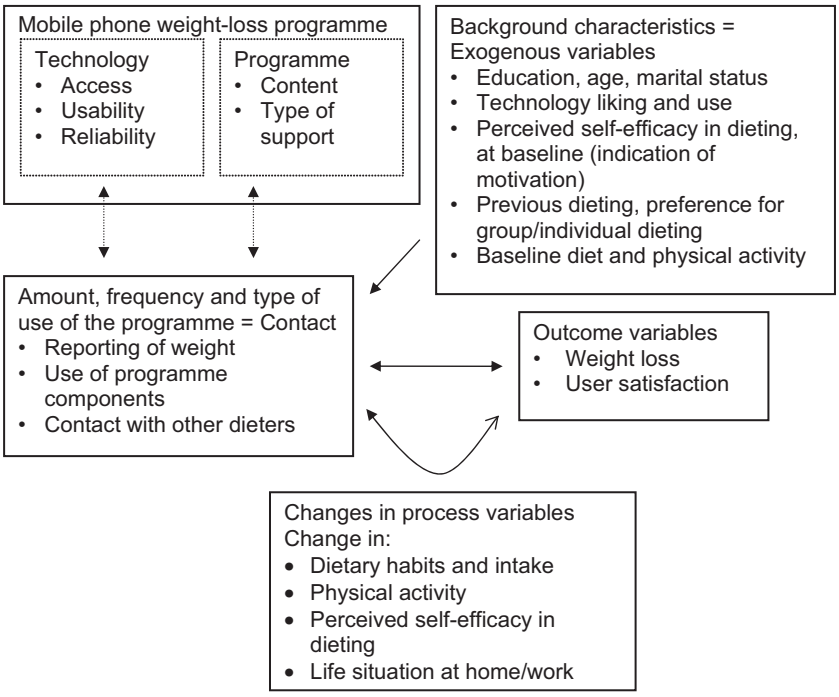

Fig. 1 Contingency model in mobile phone weight loss

Methods

Participants

One hundred and fifty-six healthy adult volunteers (120 women and thirty-six men) were recruited via newspaper advertisement and telephone screening. The chosen sample size allowed for 20 % ineligible volunteers and 30 % attrition rate to give a large enough sample to detect large effects (effect size = 0·40) with $\alpha = 0{\cdot}05$ and power of 0·80 in a 2 (treatment group) × 2 (pre-test/post-test) repeated-measures ANOVA. A total of 125 volunteers who met the eligibility criteria (age 25–44 years, BMI = 25–36 kg/m^2, access to a mobile phone and an Internet connection, no diagnosed chronic disease, no major psychiatric disease and no current, planned or previous pregnancy within 6 months) started in the study. Disease and general health-related data were based upon self-report and were discussed with the study nurse. The study nurse was blind to the randomization procedure, which was performed within gender, to an experimental group (n 62) or a control group (n 63). Signed informed consent was obtained from all participants. The participant flow is presented in Fig. 2 and the participants' characteristics in Table 1.

Design

The randomized controlled study ran from June 2001 to June 2002. To ensure objectivity and validity of weight loss, the experimental group was invited to the study centre at 3-month intervals during the 12 months of the study. The control group was invited for the baseline and the 12-month visit. Its purpose was to control for threats to internal validity (caused by selection or history) and for possible concomitant launch of a new weight-loss programme in the area. The control group received no intervention but was offered the studied weight-loss programme free of charge after the 12-month visit. No specific instruction on diet or exercise was given to either group. Because the programme was intended to serve as a support to self-directed dieters, self-directed dieting or joining another weight-loss programme was not forbidden in either group. Ethical approval for the study was obtained from the ethical committee for human research at the University of Kuopio and the Kuopio University Hospital.

Measurements

Outcome variables

Weight, height and waist circumference measurements were performed at each follow-up by two study nurses according to standardized procedures[12].

User opinions about the programme's operation and usefulness included a grade (mark) given on a scale from 4 to 10 as in the Finnish school system. Users' liking/attitudes towards mobile phones and the Internet were assessed with a yes/no question.

Amount, frequency and type of use of the programme were assessed through self-reported frequency of weight reporting via text messaging or to the website, and the use of different parts of the programme. Options were: 1 = 'every day or more' (scored as 7 times/week); 2 = '2–3 times per week' (scored as 2); 3 = 'once per week' (scored as 1); 4 = '1–2 times per month' (scored as 0·5);

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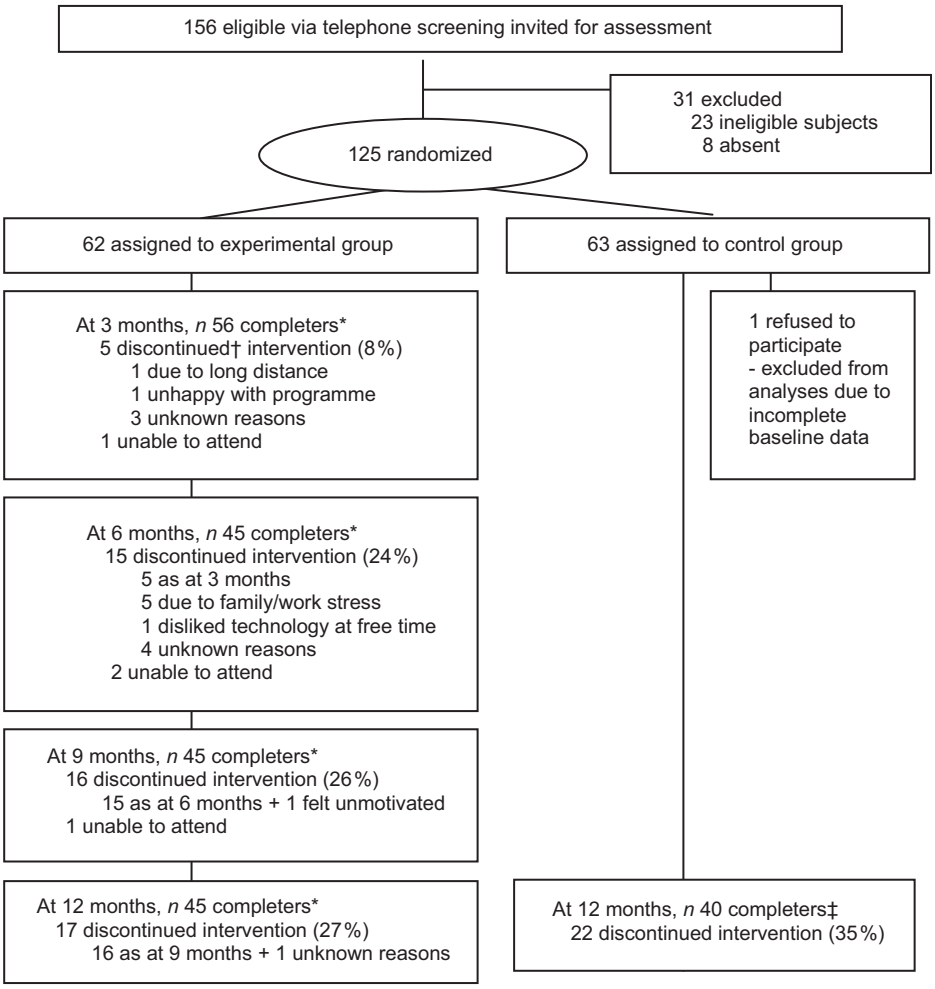

Fig. 2 Participant flow in the study (*three excluded from all analyses due to long-term medical problems (not reported at baseline); †discontinue = drop-out = withdraw from the study; ‡one excluded from all analyses due to use of the commercial weight-loss programme under study)

5 = 'less than once per month' (scored as 0·2); 6 = 'not at all' (scored as zero). Further feedback was collected with multiple choice questions to assess the type of use and the importance of different aspects of the programme.

Process variables

Dietary habits were assessed at 0, 6 and 12 months with questions related to the self-reported frequency of consuming eight energy-dense foods. The options for each ranged from 1 = 'less than once per month or never' to 5 = 'once per day or more often'. The scores were summed up to form the 'energy-dense food score' (internal consistency coefficient $\alpha = 0{\cdot}71$). Self-reported changes in dietary habits were assessed also with open-ended questions at 3 months. Dietary intake was assessed with 3 d dietary records by household measures and analysed using the Nutrica® nutrient analysis program version 3·1 (The Social Insurance Institution of Finland, Turku, Finland, 2000).

Frequency of leisure-time physical activity was assessed with a question adopted from the Finnish national health surveys (conducted by the National Public Health Institute), using seven categories ranging from 0 = 'cannot' and 1 = 'a couple of times per year or less' to 6 = 'daily'.

Self-efficacy in dieting, denoting trust in one's capability in achieving self-set goals for weight loss, reducing food intake, increasing physical activity and maintaining the weight loss, was assessed with ten items ($\alpha = 0{\cdot}84$) with a scale ranging from 0 = 'not at all certain' to 9 = 'absolutely certain' (adapted from Bandura[11]).

Changes at work and in family life were assessed with open-ended questions. The use of additional sources of information on nutrition or physical activity, and participation in other weight-loss programmes during the past year, were also assessed.

The mobile phone weight-loss programme

The present study investigated the effectiveness of a mobile phone-operated weight-loss programme, Weight Balance® (GeraCap Invia Ltd, Seinäjoki, Finland), launched in Finland in 2001. All expenses accrued due to this programme were covered. The programme calculated the dieter's daily energy requirement using an equation of

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Table 1 Baseline characteristics by group: overweight healthy adult volunteers, Finland, June 2001 to June 2002

	EG (*n* 62)		CG (*n* 62)	
Variable	Mean or *n*	SD or %	Mean or *n*	SD or %
Age (years)	38·1	4·7	38·0	4·7
Weight (kg)	87·5	12·6	86·4	12·5
BMI (kg/m^2)	30·6	2·7	30·4	2·8
Waist circumference (cm)	98·5	10·3	96·6	10·4
Sex				
Females	49	79	47	76
Males	13	21	15	24
Education*				
Vocational school	10	16	11	18
College degree/baccalaureate	44	71	31	50
Graduate degree	5	8	14	23
Marital status				
Married/co-habiting	53	85	50	81
Like using mobile phones (yes)†	56	90	52	85
Used mobile phones for >2 years (yes)†	54	87	48	79
Like using the Internet (yes)*†	60	97	49	80
Years of Internet use‡	3·3	1·7	2·6	1·9
Have prior experience with dieting (yes)§	54	87	50	81
Prefer dieting alone *v.* in a group (yes)§	28	54	27	49

EG, experimental group; CG, control group.
*$P > 0{\cdot}05$, χ^2 test between groups.
†Missing data for one subject in CG.
‡$P > 0{\cdot}05$, *t* test between groups.
§Missing data for ten subjects in EG, seven in CG.

Owen *et al.*[13] and physical activity coefficients adapted from Shetty *et al.*[14]. It was designed to discourage daily energy intakes below 800 kcal, participation by children (younger than 18 years of age) and participation by anyone with a BMI below 18 kg/m^2. After receiving information on the dieter's current weight, the programme sent a text indicating the percentage dieters had reached for the day's target weight; the extent to which they had reached their daily weight goal; the amount of food to be consumed in proportion to the subject's normal diet, as a fraction, percentage and as energy (3/4, 75 %, 1500 kcal); and the days remaining until the target. The programme was based on text messages; there were no phone calls made. The initiation was made by the study participant who sent the first text message. All messages sent by the study participant led to an automatically generated, tailored response text message.

The programme advised the dieters to start reducing their food intake by leaving out 'unnecessary foods' high in sugar and/or fat and to cut down on alcohol. It encouraged an increase in daily physical activity and emphasized the need for regular weight reporting, either via text messaging or through the programme's password-protected website. The website provided a personal (password-protected) webspace for dietary record keeping and tracking one's weight loss in visual form. It also offered links to reliable sources of information on healthy nutrition and physical activity. The programme is currently available only in Finnish at http://www.weightbalance.fi.

Dieters in the present study were allowed to set their target weight either as a short- or a long-term goal and to adjust it as needed at every 3-month visit. After the user reached the set target weight, he/she could still use the programme for weight-loss maintenance. As a rule, weight loss was started at 2 kg/month. Those who wished to start at a faster pace (the fastest being 4·8 kg/month) were closely monitored via the web tracking system, which provided the research team access to the dieter's personal weight charts.

Data analysis

Repeated-measures ANOVA was used to test for changes in dependent, normally distributed continuous variables over time within and between groups. An intention-to-treat analysis was also run using baseline weight, or weight carried forward from last observation if it was higher, for any missing data for those who withdrew from the study. Bivariate correlation and linear regression analyses were run to assess the relationship between contact with the programme and background, process and outcome variables. In keeping with our theoretical model, we first evaluated how well the background and process variables predicted average weekly contact with the programme at 3 months. Variables with a bivariate correlation to the criterion were entered stepwise into the models in sets of background and process variables using SPSS PC® for Windows statistical software package release 10·0·5 (SPSS Inc., Chicago, IL, USA).

Results

Background characteristics and withdrawal from the study

The experimental (*n* 62) and control group (*n* 62) did not differ on any of the background characteristics or baseline

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measurements (Table 1). In the experimental group, subjects who withdrew (discontinued) from the study (see Fig. 2) did not significantly differ on any background variables but lost less weight by 3 months than those who continued in the study (1·0 (SD 3·4) *v.* 5·3 (SD 3·5) %, $t = 3·7$, $P < 0·0001$). Completers of the 12 months and those who discontinued the study and provided feedback (n 14) reported similar high grades for programme operation and usefulness: 7·3 (SD 1·2) *v.* 7·9 (SD 1·0), $P < 0·053$ (on a scale from 4 to 10). Reasons for discontinuing in the study included increased stress at work or studying (n 3), changes in personal life situation (n 3), not feeling up to the challenge alone (n 2) and preferring to turn the mobile phone and computer off after work (n 1).

Programme effectiveness

Short- and long-term results

Repeated-measures ANOVA indicated a significant time effect for weight loss across the 3-month intervals ($F(4,38) = 24·5$, $P < 0·0001$) and a significant time by group interaction at 12 months in favour of the experimental group (by 4·1 (SD 1·4) %; $F(1,80) = 8·0$, $P = 0·006$; Table 2). Most of the weight loss in the experimental group took place during the first three months (4·5 (SD 3·1) kg) while the cumulative reduction was highest at 6 months (5·2 (SD 4·4) kg). By 12 months, the experimental group had lost 4·5 (SD 5·0) kg ($t = 5·8$, $P < 0·0001$) while the weight loss among the controls was non-significant (1·1 (SD 5·8) kg; $t = 1·2$, $P = 0·247$; Table 2). Adding participation in other weight-loss programmes as a cofactor in repeated-measures ANOVA had no significant effect on the results in weight loss. In the experimental group, 24% (n 10) of the subjects lost at least 10% of their initial weight by 12 months, while 10% (n 4) of controls succeeded in this. The percentage achieving at least 5% weight loss and keeping it off for 12 months was 45% (n 19) and 20% (n 8) in the experimental and control group, respectively. The reduction in waist circumference showed a similar pattern, with a significant reduction by 12 months in both groups that was greater in the experimental group: 6·3 (SD 5·3) *v.* 2·4 (SD 5·4) cm (Table 2).

Intention-to-treat analyses indicated a significant time effect ($F(1,118) = 18·8$, $P < 0·0001$) and time by group interaction in favour of the experimental group ($F(1,118) = 7·4$, $P = 0·008$): reduction of 3·1 (SD 4·9) kg ($t = 4·9$, $P < 0·0001$) *v.* 0·7 (SD 4·7) kg ($t = 1·2$, $P = 0·245$). Similarly, intention-to-treat analysis for the reduction in waist circumference indicated a significant time effect ($F(1,18) = 46·0$, $P < 0·0001$) and time by group interaction in favour of the experimental group ($F(1,118) = 11·0$, $P = 0·002$): reduction of 4·5 (SD 5·3) cm ($t = 6·5$, $P = 0·0001$) *v.* 1·6 (SD 4·5) cm ($t = 2·8$, $P = 0·008$).

User satisfaction

The participants gave the programme a relatively high score on a scale from 4 to 10: 7·8 (SD 0·8) at 12 months (n 42).

Amount, frequency and type of use

Overall frequency of use of the programme faded from 8 times per week to 3–4 times per week by 12 months

Table 2 Outcome variables by group at 3-month intervals for completers of 12 months in both groups: overweight healthy adult volunteers, Finland, June 2001 to June 2002

	Baseline		3 months		6 months		9 months		12 months	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Body weight (kg)*										
EG (n 42)	86·6	12·7	82·0	12·9	81·4	13·6	81·8	13·8	82·1	14·1
CG (n 40)	85·1	12·5	–	–	–	–	–	–	84·0	13·2
Percentage weight loss†										
EG (n 42)	–	–	5·3	3·5	6·1	5·1	5·6	5·6	5·4	5·8
CG (n 40)	–	–	–	–	–	–	–	–	1·3	6·5
Waist circumference (cm)‡										
EG (n 42)	97·6	10·5	91·7	10·4	90·9	11·2	91·1	11·6	91·3	11·7
CG (n 40)	95·7	10·9	–	–	–	–	–	–	93·3	11·1
Self-efficacy in dieting§										
EG (n 40)	7·0	1·1	7·0	1·2	6·7	1·1	6·6	1·3	6·4	1·7
CG (n 40)	7·0	1·0	–	–	–	–	–	–	6·6	1·4
Energy-dense food score‖										
EG (n 41)	2·9	0·6	–	–	2·4	0·6	–	–	2·6	0·6
CG (n 40)	2·7	0·7	–	–	–	–	–	–	2·6	0·7

EG, experimental group; CG, control group.

*Time effect: $F(4,38) = 24·5$, $P = 0·0001$; time by group interaction: $F(1,80) = 8·0$, $P = 0·006$. For EG, significant difference from baseline at each time point ($P < 0·0001$); for CG, non-significant change.

†Significant difference between groups at 12 months: $t = 3·0$, $P = 0·003$.

‡Time effect: $F(4,38) = 30·1$, $P = 0·0001$; time by group interaction: $F(1,80) = 55·2$, $P = 0·0001$. For EG, significant difference from baseline at each time point ($P < 0·0001$); for CG, significant change: $t = 2·8$, $P = 0·0008$.

§Trust in one's capability of achieving the self-set goals for weight loss, reducing food intake, increasing physical activity and maintaining the weight loss on 10-point scales: 0 = 'I am not at all certain' to 9 = 'I am absolutely certain'. Significant decrease for EG, Friedman test and Kendall's W: $\chi^2 = 10·2$, $P = 0·05$. Significant decrease in CG, Wilcoxon test: $Z = -2·08$, $P = 0·04$. In EG, significant change only between 3-month and 12-month scores: $Z = 2·05$, $P = 0·05$.

‖Energy-dense foods score scale, consumption frequency for eight food items (internal consistency coefficient = 0·71, n 116): 1 = 'less than once per month or never', 2 = 'once or twice per month', 3 = 'once per week', 4 = 'once or twice per week', 5 = 'once per day or more often'. Time effect: $F(2,39) = 27·6$, $P = 0·0001$; time by group interaction: $F(1,80) = 5·6$, $P = 0·03$. For EG, significant difference from baseline at each time point ($P < 0·0001$); for CG, non-significant change.

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Table 3 Frequency of self-reported weight reporting and contact with the programme for completers of 12 months (*n* 40): overweight healthy adult volunteers, Finland, June 2001 to June 2002

	3 months		6 months		9 months		12 months	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Reporting via mobile phone per week*	4·4	2·8	2·6	2·8	1·6	2·4	1·1	1·8
Reporting via Internet per week†	1·9	2·1	1·9	2·5	1·4	2·2	1·2	2·0
Total number of contacts per week‡	8·2	4·0	5·7	4·6	3·7	3·5	3·1	3·5

*Time effect: $F(3,37) = 18{\cdot}7$, $P = 0{\cdot}0001$.
†Significant time effect: $F(3,37) = 16{\cdot}5$, $P = 0{\cdot}0001$.
‡The total amount of contact = weight reporting via mobile phone and Internet, plus other use of the programme website.

(Table 3). Those with more than 5% weight loss at 12 months reported more frequent weekly contact at 3 months than those who had lost less than 5% (9·7 (SD 3·7) *v.* 7·0 (SD 3·8) times; $t = 2{\cdot}31$, $P < 0{\cdot}05$). Mobile phones were the predominant medium for weight reporting and keeping in contact with the programme (Table 3).

The four most useful features of the programme listed at 3 months were: the use of mobile phones and the Internet (93% agreement), that the programme was free of charge (93%), regular reporting of weight (91%) and immediate feedback (90%). By 12 months, setting short-term goals was also reported as useful (95%).

Within the experimental group, 56% reported at 3 months that they had searched for more information on healthy diet, while only 12% had looked up information on physical activity to support weight loss. At 12 months, 33% of the participants reported having searched for more information on physical activity. In the control group, 33% reported having searched for more information on a healthy diet and 20% on physical activity. The most common sources reported were the Internet, books, brochures and old notes from previous weight-loss attempts.

Process variables

Dietary habits, nutritional intake and physical activity

At 3 months, 83% of the completers reported having made some improvements to their diet. Most common changes were: reduced fat intake (48%), reduced amount of sugar and sweets (33%) or of food overall (29%) and increased amounts of vegetables (17%). The average number of positive changes reported at 3 months was 1·6 (SD 1·1). Energy-dense food scores indicated a significant change in consumption of this type of food (Table 2). Nutritional intake analysis did not indicate significant a change in average daily energy intake from 7297 (SD 1975) kJ/d in the experimental group (*n* 25) or 7263 (SD 1937) kJ/d in the control group (*n* 21). Physical activity increased on average in both groups, from 2–3 times per month to once per week ($P < 0{\cdot}05$).

Changes in self-efficacy and life situation

At 12 months, perception of dietary self-efficacy showed a significant decrease from baseline (Table 2). However, it increased from 6·7 (SD 1·4) (on a scale from 0 to 9, high scores indicating stronger trust in one's capabilities in dieting) among those who had lost at least 5% of initial weight by 12 months (by 0·3 (SD 1·2), $P = 0{\cdot}46$), but decreased from 7·3 (SD 0·8) (by 1·3 (SD 1·9), $P = 0{\cdot}008$) among those who had gained weight or lost less than 5% by 12 months. Life situation at home had changed during the 12 months for fifteen subjects due to a move, major celebration, injury, illness in the family or other family reasons; thirty-two subjects reported having experienced such stress at work that it had negatively impacted on their weight loss.

Predictors of weight loss

Correlation analyses between contact with the programme, background, process and outcome variables (see Fig. 1 for theoretical modelling) are presented for short-term (3 months) and long-term (12 months) data in Table 4. Because of the strong correlation between short- and longer-term weight loss results, we concentrated our analysis on finding the predictors of weight loss at 3 and 12 months (Table 5) in addition to those for programme contact (see Table 5).

For 'contact with the programme', the most parsimonious prediction equation consisted of one background (liking teletechnology) and three process variables (number of positive changes made in the diet, seeking more information on nutrition and self-reported changes at work), which accounted for a significant amount (41%) of the average contact variability (Table 5). The best prediction equation for weight loss at 12 months consisted of percentage weight loss at 3 months and change in self-efficacy from baseline, accounting for 65% of the variance in the criterion (Table 5). For the 3-month weight loss, background variables did not significantly add to the prediction equation over and above the two process variables (change in self-efficacy in dieting and seeking information on nutrition at 3 months), amount of use of the programme and the grades given to the programme. This model explained 62% of the variance in the criterion (weight loss at 3 months; Table 5).

Discussion

The present study showed that mobile phone delivery can be considered an effective method for supporting

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Table 4 Correlations* between percentage weight loss at 3 and 12 months and background and process variables for completers of 3 months and completers of 12 months: overweight healthy adult volunteers, Finland, June 2001 to June 2002

	Completers of 3 months			Completers of 12 months				
						Percent weight loss at		
	Weekly contact	Percent weight loss at 3 months		Weekly contact during 12 months		3 months	12 months	
	r	*r*	*n*	*r*	*n*	*r*	*r*	*n*
Background characteristics								
Level of education	0·10	0·29	52	0·11	41	0·23	0·39	41
Liking teletechnology (1 = no, 2 = yes)	0·39	0·28	52	0·34	41	0·29	0·24	41
Energy-dense food score	0·02	−0·24	52	−0·19	41	−0·31	−0·43	41
Energy intake (kcal) at baseline	−0·05	−0·19	45	−0·35	37	−0·39	−0·38	37
Process variables								
Changes at work at the time point (1 = yes, 2 = no)	0·41	0·39	52	0·41†	40	0·36	0·08	41
Changes at home at the time point (1 = yes, 2 = no)	0·26	0·20	52	0·41†	40	0·32	0·16	41
Seeking for information on nutrition at 3 months	0·39	0·53	51	0·25	40	0·38	0·39	40
Number of self-reported changes in dietary habits at 3 months	0·43	0·51	52	0·21	41	0·44	0·11	41
Change in energy-dense food score at 12 months	−0·07	n/a		0·17	41	0·16	0·03	41
Change in self-efficacy at the time point	0·29	0·51	52	0·15‡	41	0·41	0·68	41
Weekly contact at the time point	1·00	0·62	52	0·35§	41	0·57	0·38	41
Outcome variables								
Grade for the programme at the time point	0·40	0·55	51	0·55‖	41	0·58	0·36	41
Percentage weight loss at 3 months	0·62	1·00	52	0·59	41	1·00	0·63	41
Percentage weight loss at 12 months	0·28	0·67	40	0·36	41	0·63	1·00	41

n/a, not applicable for the participants at 3 months.
*With *n* 52, coefficients were significant at the $P < 0·05$ level when $r > 0·28$, at the $P < 0·01$ level when $r > 0·39$ and at the $P < 0·001$ level when $r > 0·51$. With *n* 40, respectively when $r > 0·31$, $r > 0·40$ and $r > 0·54$.
†Correlation between changes at work and home and contact at 3 months.
‡Correlation between the change in self-efficacy from baseline at either time point.
§Correlation between percentage weight loss at 1 year and average weekly contact.
‖Correlation between average 12-month grade and average weekly contact.

Table 5 Multiple regression models for predicting contact, 3-month and 12-month weight loss: overweight healthy adult volunteers, Finland, June 2001 to June 2002

Variable	Cumulative R^2	*B* coefficient	SEE	*P*	Univariate R^2	*B* coefficient	SEE
Predicting weekly amount of contact at 3 months: $R^2 = 0·41$, $R = 64$, $F(4,46) = 8·0$, $P < 0·0001$							
Number of positive self-reported changes in dietary habits	0·16	0·84	4·08	0·003	0·18	1·74	4·10
Baseline liking of the use of teletechnology (1 = no, 2 = yes)	0·25	−7·27	3·90	0·020	0·15	−8·82	4·18
Seeking more information on nutrition, reported at 3 months (1 = no, 2 = yes)	0·35	2·60	3·68	0·011	0·16	3·46	4·10
Changes at work by 3 months (1 = yes, 2 = no)	0·41	2·45	3·54	0·033	0·17	3·78	4·15
Predicting weight loss at 3 months: $R^2 = 0·62$, $R = 79$, $F(4,46) = 18·5$, $P < 0·0001$							
Seeking more information on nutrition, reported at 3 months (1 = no, 2 = yes)	0·28	1·68	3·37	0·0001	0·28	4·11	3·37
Change in self-efficacy from baseline to 3 months (3 months minus baseline value)	0·42	0·77	3·04	0·001	0·26	1·35	3·41
Weekly amount of contact with the programme reported at 3 months	0·55	0·28	2·71	0·001	0·38	0·54	3·13
Grade for the programme at 3 months	0·62	1·06	2·53	0·007	0·31	2·0	3·30
Predicting weight loss at 12 months: $R^2 = 0·65$, $R = 81$, $F(2,38) = 35·2$, $P < 0·0001$							
Change in self-efficacy from baseline to 12 months (12 months minus baseline value)	0·46	1·66	4·20	0·0001	0·46	2·13	4·20
Percentage weight loss from baseline	0·65	0·72	3·40	0·0001	0·40	1·0	4·50

B coefficient, unstandardized *B* coefficient; *P*, significance of contribution of each additional parameter to the stepwise multiple regression model; univariate R^2, single variable entered into the prediction equation; SEE, standard error of the estimate.

short- (3 months) and long-term (12 months) weight loss. With mobile phone delivery, weight loss can be dependent upon the amount and type of programme use and learning (changes in health behaviour and self-efficacy) taking place in that process and not solely on information arising from the programme. Weight loss was positively influenced by programme contact. Keeping in contact with the programme, on the other hand, may be a process influenced by social context, as indicated by the negative impact of work stress on contact with the programme under study.

Long-term (12-month) reductions in weight and waist circumference in the experimental group were equal to or greater than those previously reported from minimal-contact or minimal-advice programmes[15–19] and from more labour-intensive Internet-based programmes[1,3–7]. Findings are also in line with a recent meta-analysis of US studies, indicating that higher initial weight loss (>20 kg) was associated with successful loss maintenance, and only a 3 % reduction from the initial weight was maintained at 5 years after participation[20].

The associations seen in our study between short-term (3 months) weight loss and the amount of programme use, satisfaction, change in self-efficacy and seeking information on nutrition highlight the mediating role of new technologies in supporting self-directed, active participation in learning new health behaviours. Successful self-directed learners are said to 'show interest, personal efficacy, enthusiasm, and even comfort in controlling their own learning activities'[21]. Such active participation in a weight-loss programme has been shown to predict long-term weight-loss maintenance[22,23]. With the new technology, attitudes towards teletechnology may serve as strong predictors of health behaviour change because they can influence the amount of programme use (contact), as indicated in the present study.

In prior research, continued contact with the group, therapist or the programme leader has been shown to be a major predictor of success in weight loss[4,24,25], and successful long-term weight-loss maintenance has been related to frequent self-monitoring of body weight and food intake[26–28]. In our study, the more frequent the reporting of weight via text messaging had been, the more weight was lost at 12 months as a percentage of initial weight. The nature of this relationship is unclear. However, it is possible to gain some insights from the participants' responses. For example, dieters seemed to appreciate the independence of time and place in keeping in touch with the weight-loss programme. The preferred medium for weight reporting in the current study was the mobile phone (4·4 (SD 2·8) times per week during the first three months). The Internet was used once or twice weekly for weight reporting and other programme activities, thus the average weekly contact with the programme during the first twelve months was 5·0 (SD 3·2) times per week (median 4·6; range 0·2 to 12·7 times per week). This shows that the self-directed participation

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(contact) in the current study was more than double the log-in frequency in a recent study of an Internet-only group[7] and considerably higher than in previously reported Internet-based programmes[4,6].

Our finding that baseline self-efficacy was not as strong a predictor as change during the programme indicated that the programme may have succeeded in providing positive opportunities for performance accomplishment, verbal persuasion, vicarious performance and physiological or affective arousal: the sources of self-efficacy identified by Bandura[11]. Supported by previous research[29,30], our findings also suggest that baseline self-efficacy appraisals may be overly optimistic and unconnected to practical skills or opportunities to overcome possible obstacles encountered in personal life or at work. In our study, starting from a lower level of baseline self-efficacy, those who achieved and maintained at least 5% weight loss reported significantly higher 12-month self-efficacy than those who lost less than 5% or gained weight by 12 months.

Our results suggest that life circumstances may have a significant impact on willingness to persevere with the programme. The amount of use of the programme was negatively influenced by self-reported negative changes at work at all time points, and this was, in fact, the main reason reported (n 6) for discontinuing in the study.

The present study examined two aspects of self-directed behaviour: (i) the micro qualities of the medium through which the communication of messages and feedback takes place; and (ii) the macro qualities of the life-space of the participant. Further research into the micro qualities of the medium requires further longitudinal studies with qualitative methodology to capture the participants' perceptions of the usefulness of programme features. Answers to the macro qualities may require connecting weight-loss programmes with life counselling, as also suggested by others[22,31].

As a limitation of our study, the 12-month results may overestimate effects of the programme itself on weight loss because of the 3-monthly in-person weigh-ins. However, even with these short visits to the study centre, the programme remained a minimal-advice and minimally labour-intensive intervention that could cost-effectively be incorporated into everyday health-care practice. Another limitation may be that the data regarding physical activity and dietary habits were collected using a self-administered questionnaire and thus constitute self-reported data. However, this is the usual method for nutritional research which enables comparisons with prior research. Furthermore, at the time of our study, we could not identify a previously validated measure of energy-dense foods in the Finnish population.

The important new approach of the present study is that it combined existing behaviour change theory with a theoretical model of adult learning and interaction with new media. This allowed us to critically assess the power of the feedback medium itself. Mobile phones have the advantage of being spatially flexible and providing succinct messages, which are easily assimilated. Also, people associate certain qualities to the use of mobile phones: it is a medium for two-way communication with others and is a self-adopted medium, recognizing the dieter as an active participant.

In conclusion, the current results indicate that mobile phone delivery, in conjunction with user-determined Internet access, may be used to develop an effective medium for short- and long-term weight loss.

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