The effectiveness of app-based mobile interventions on nutrition behaviours and nutrition-related health outcomes: A systematic review and meta-analysis

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Supporting Information

Review

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Supporting Information 1

PRISMA checklist[49]

Section/topic	#	Checklist item	Item fulfilled
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	yes
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	yes
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	yes
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	yes
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	The review was conducted in accordance to a pre-defined but not published protocol
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	yes
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	yes
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	yes

Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	yes
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	yes
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	yes
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	yes
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	yes
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	yes
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	yes
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	yes
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	yes
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	yes
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	yes
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	yes
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	yes
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	yes

Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	yes
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	yes
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	yes
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	yes
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	yes

Supporting Information 2

Search strategy with general search terms used in the searches

Search category	Search terms
App	ambulatory assessment OR ecological momentary assessment OR EMA OR mHealth OR mobile health OR smartphone OR smart phone OR smartphone intervention OR smartphone application OR mobile application OR smartphone app OR mobile app OR mobile intervention OR mobile technology OR mobile technologies OR mobile phone OR mobile device
Outcomes	healthy eating OR diet OR dietary OR food OR foods OR nutrition OR eating OR fruit OR fruits OR vegetable OR vegetables OR snack OR snacks OR snacking OR energy intake OR calorie intake OR caloric intake OR dietary intake OR dietary behavior OR food intake OR nutrient intake OR nutritional intake OR BMI OR body mass index OR adiposity OR weight OR body weight OR weight management OR weight loss OR weight reduction OR obesity OR obese OR health behavior OR health behavior change
Terms excluded	anti endomysial antibody OR IgA-endomysium antibodies OR eugenyl methacrylate OR epithelial membrane antigen OR ethylmethacrylate OR European Medicines Agency OR serum endomysial antibodies OR mental health

MEDLINE and Web of Science

Search Term:

TOPIC: ((ambulatory assessment OR ecological momentary assessment OR EMA OR mHealth OR mobile health OR smartphone OR smart phone OR smartphone intervention OR smartphone application OR mobile application OR smartphone app OR mobile app OR mobile intervention OR mobile technology OR mobile technologies OR mobile phone OR mobile device) AND (healthy eating OR diet OR dietary OR food OR foods OR nutrition OR eating OR fruit OR fruits OR vegetable OR vegetables OR snack OR snacks OR snacking OR energy intake OR calorie intake OR caloric intake OR dietary intake OR dietary behavior OR food intake OR nutrient intake OR nutritional intake OR BMI OR body mass index OR adiposity OR weight OR body weight OR weight management OR weight loss OR weight reduction OR obesity OR obese OR health behavior OR health behavior change) NOT (anti endomysial antibody OR IgA-endomysium antibodies OR eugenyl methacrylate OR epithelial membrane antigen OR ethylmethacrylate OR European Medicines Agency OR serum endomysial antibodies OR mental health))

Limits:

- Publication date: 01/01/2006 – 01/06/2017
- Language: English
- Search for: Topic

Hits:

- *k* = 8,765

PubMed

Search Term:

(((ambulatory assessment[Title/Abstract] OR ecological momentary assessment[Title/Abstract] OR EMA[Title/Abstract] OR mHealth[Title/Abstract] OR mobile health[Title/Abstract] OR smartphone[Title/Abstract] OR smart phone[Title/Abstract] OR smartphone intervention[Title/Abstract] OR smartphone application[Title/Abstract] OR mobile application[Title/Abstract] OR smartphone app[Title/Abstract] OR mobile app[Title/Abstract] OR mobile intervention[Title/Abstract] OR mobile technology[Title/Abstract] OR mobile technologies[Title/Abstract] OR mobile phone[Title/Abstract] OR mobile device[Title/Abstract])) AND (healthy eating[Title/Abstract] OR diet[Title/Abstract] OR dietary[Title/Abstract] OR food[Title/Abstract] OR foods[Title/Abstract] OR nutrition[Title/Abstract] OR eating[Title/Abstract] OR fruit[Title/Abstract] OR fruits[Title/Abstract] OR vegetable[Title/Abstract] OR vegetables[Title/Abstract] OR snack[Title/Abstract] OR snacks[Title/Abstract] OR snacking[Title/Abstract] OR energy intake[Title/Abstract] OR calorie intake[Title/Abstract] OR caloric intake[Title/Abstract] OR dietary intake[Title/Abstract] OR dietary behavior[Title/Abstract] OR food intake[Title/Abstract] OR nutrient intake[Title/Abstract] OR nutritional intake[Title/Abstract] OR BMI[Title/Abstract] OR body mass index[Title/Abstract] OR adiposity[Title/Abstract] OR weight[Title/Abstract] OR body weight[Title/Abstract] OR weight management[Title/Abstract] OR weight loss[Title/Abstract] OR weight reduction[Title/Abstract] OR obesity[Title/Abstract] OR obese[Title/Abstract] OR health behavior[Title/Abstract] OR health behavior change[Title/Abstract])) NOT (anti endomysial antibody[Title/Abstract] OR IgA-endomysium antibodies[Title/Abstract] OR eugenyl methacrylate[Title/Abstract] OR epithelial membrane antigen[Title/Abstract] OR ethylmethacrylate[Title/Abstract] OR European Medicines Agency[Title/Abstract] OR serum endomysial antibodies[Title/Abstract] OR mental health[Title/Abstract])

Limits:

- Publication date: 01/01/2006 – 01/06/2017
- Language: English
- Search for: Title and abstract

Hits:

- *k* = 1,679

PsychInfo, PsychIndex, PsychArticle, SPORTDiscuss

Search Term:

(ambulatory assessment OR ecological momentary assessment OR EMA OR mHealth OR mobile health OR smartphone OR smart phone OR smartphone intervention OR smartphone application OR mobile application OR smartphone app OR mobile app OR mobile intervention OR mobile technology OR mobile technologies OR mobile phone OR mobile device) AND (healthy eating OR diet OR dietary OR food OR foods OR nutrition OR eating OR fruit OR fruits OR vegetable OR vegetables OR snack OR snacks OR snacking OR energy intake OR calorie intake OR caloric intake OR dietary intake OR dietary behavior OR food intake OR nutrient intake OR nutritional intake OR BMI OR body mass index OR adiposity OR weight OR body weight OR weight management OR weight loss OR weight reduction OR obesity OR obese OR health behavior OR health behavior change) NOT (anti endomysial antibody OR IgA-endomysium antibodies OR eugenyl methacrylate OR epithelial membrane antigen OR ethylmethacrylate OR European Medicines Agency OR serum endomysial antibodies OR mental health)

Limits:

- Publication date: 01/01/2006 – 01/06/2017
- Language: English
- Search for: All fields

Hits:

- k = 1,263

Supporting Information 3

List of excluded studies and reasons (k = 60)

***k* = 19: No app or automated feedback**
Allman-Farinelli M, Partridge SR, McGeechan K, et al. A mobile health lifestyle program for prevention of weight gain in young adults (TXT2BFiT): Nine-month outcomes of a randomized controlled trial. *JMIR mHealth and uHealth* 2016; **4**(2): e78. doi: 10.2196/mhealth.5768. Bentley CL, Otesile O, Bacigalupo R, et al. Feasibility study of portable technology for weight loss and HbA1c control in type 2 diabetes. *BMC Medical Informatics and Decision Making* 2016; **16**(92). doi: 10.1186/s12911-016-0331-2. Blackburne T, Rodriguez A, Johnstone SJ. A serious game to increase healthy food consumption in overweight or obese adults: Randomized controlled trial. *JMIR Serious Games* 2016; **4**(2): e10. doi: 10.2196/games.5708. Burke LE, Styn MA, Sereika SM, et al. Using mHealth technology to enhance self-monitoring for weight loss: A randomized trial. *American Journal of Preventive Medicine* 2012; **43**(1): 20-26. doi: 10.1016/j.amepre.2012.03.016. Ni Mhurchu C, Whittaker R, McRobbie H, et al. Feasibility, acceptability and potential effectiveness of a mobile health (mHealth) weight management programme for New Zealand adults. *BMC Obesity* 2014; **1**(10). doi: 10.1186/2052-9538-1-10. O'Brien T. *Mobile health technology interventions to improve the health status of older rural women*. (Doctoral dissertation, Medical University of South Carolina); South Carolina, 2013. Sysko R. Comment on: Feasibility of ecological momentary assessment to characterize adolescent postoperative diet and activity patterns following weight loss surgery. *Surgery for Obesity and Related Diseases: Official Journal of the American Society for Bariatric Surgery* 2014; **10**(4): 711-2. doi: 10.1016/j.soard.2014.02.012. Waki K, Fujita H, Uchimura Y, et al. DialBetics: A novel smartphone-based self-management support system for type 2 diabetes patients. *Journal of Diabetes Science and Technology* 2014; **8**(2): 209-15. doi: 10.1177/1932296814526495. Nystrom CD, Sandin S, Henriksson P, et al. Mobile-based intervention intended to stop obesity in preschool-aged children: The MINISTOP randomized controlled trial. *The American Journal of Clinical Nutrition* 2017, **105**(6): 1327-35. doi: 10.3945/ajcn.116.150995. Byrne S, Gay G, Pollack JP, et al. Caring for mobile phone-based virtual pets can influence youth eating behaviors. *Journal of Children and Media* 2012; **6**(1): 83-99. doi: 10.1080/17482798.2011.633410. Zhou WB, Chen M, Yuan JY, Sun Y. Welltang - A smartphone-based diabetes management application improves blood glucose control in Chinese people with diabetes. *Diabetes Research and Clinical Practice* 2016; **116**: 105-10. doi: 10.1016/j.diabres.2016.03.018.

Ambeba EJ, Ye L, Sereika SM, et al. The use of mHealth to deliver tailored messages reduces reported energy and fat intake. *Journal of Cardiovascular Nursing* 2015; **30**(1): 35-43. doi: 10.1097/JCN.0000000000000120.

Hutcheson TD. *Using mobile technology to impact fruit and vegetable consumption in low-income youth*. (Doctoral dissertation, University of Kansas); Kansas, 2012.

Nollen NL, Hutcheson T, Carlson S, et al. Development and functionality of a handheld computer program to improve fruit and vegetable intake among low-income youth. *Health Education Research* 2013; **28**(2): 249-64. doi: 10.1093/her/cys099.

Nollen NL, Mayo MS, Carlson SE, Rapoff MA, Goggin KJ, Ellerbeck EF. Mobile technology for obesity prevention: A randomized pilot study in racial- and ethnic-minority girls. *American Journal of Preventive Medicine* 2014; **46**(4): 404-08. doi: 10.1016/j.amepre.2013.12.011.

Schneider KL, Coons MJ, McFadden HG, et al. Mechanisms of change in diet and activity in the Make Better Choices 1 trial. *Health Psychology* 2016; **35**(7): 723-32. doi: 10.1037/hea0000333.

Spring B, Duncan JM, Janke EA, et al. Integrating technology into standard weight loss treatment: A randomized controlled trial. *JAMA Internal Medicine* 2013; **173**(2): 105-11. doi: 10.1001/jamainternmed.2013.1221.

Spring B, Schneider K, McFadden G, et al. Multiple behavior changes in diet and activity: A randomized controlled trial using mobile technology. *Archives of Internal Medicine* 2012; **172**(10): 789-96. doi: 10.1001/archinternmed.2012.1044.

Welch JL, Astroth KS, Perkins SM, et al. Using a mobile application to self-monitor diet and fluid intake among adults receiving hemodialysis. *Research in Nursing & Health* 2013; **36**(3): 284-98. doi: 10.1002/nur.21539.

***k* = 10: No results reported / no study conducted**

Arsand E, Varmedal R, Hartvigsen G. Usability of a mobile self-help tool for people with diabetes: The Easy Health Diary. In: *2007 IEEE International Conference on Automation Science and Engineering*. Scottsdale, AZ: IEEE; 2007. pp. 863–868. doi: 10.1109/COASE.2007.4341807.

Bojic M, Blanson Henkemans OA, Neerincx MA, Van der Mast CA, Lindenberg J. Effects of multimodal feedback on the usability of mobile diet diary for older adults. In: Stephanidis C (ed). *Universal Access in Human-Computer Interaction. Applications and Services*. Berlin: Springer; 2009. pp. 293–302. doi: 10.1007/978-3-642-02713-0_31.

De Cock N, Vangeel J, Lachat C, et al. Use of fitness and nutrition apps: Associations with body mass index, snacking, and drinking habits in adolescents. *JMIR mHealth and uHealth* 2017; **5**(4): e58. doi: 10.2196/mhealth.6005.

Ernsting C, Dombrowski SU, Oedekoven M, et al. Using smartphones and health apps to change and manage health behaviors: A population-based survey. *Journal of Medical Internet Research* 2017; **19**(4): e101. doi: 10.2196/jmir.6838.

Gao CM, Kong FY, Tan JD. HealthAware: Tackling obesity with health aware smart phone systems. *Proceedings of the IEEE International Conference on Robotics and Biomimetics* 2009; 1549-54. doi: 10.1109/ROBIO.2009.5420399.

Kato S, Waki K, Nakamura S, et al. Validating the use of photos to measure dietary intake: The method used by DialBetics, a smartphone-based self-management system for diabetes patients. *Diabetology International* 2016; **7**: 244–251. doi: 10.1007/s13340-015-0240-0.

Putri RCRW. NomNom, mobile app about digestive health for children. In: *Global society and new media: International Conference on New Media 2015 Universitas Multimedia Nusantara, Indonesia, November 25th-27th*. Piscataway, NJ: IEEE; 2015. pp. 1–5. doi: 10.1109/CONMEDIA.2015.7449151.

Robinson E, Higgs S, Daley AJ, et al. Development and feasibility testing of a smart phone based attentive eating intervention. *BMC Public Health* 2013; **13**(639). doi: 10.1186/1471-2458-13-639.

Tommasone G, Bazzani M, Solinas V, Serafini P. Midwifery e-Health: From design to validation of "Mammastyle — Gravidanza Fisiologica". In: *2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom)*. Piscataway, NJ: IEEE; 2016. pp. 1–6. doi: 10.1109/HealthCom.2016.7749499.

Youm S, Park SH. Development and evaluation of a mobile application for personal lifestyle check-up and improvement. *Telemedicine and E-Health* 2014; **20**(11): 1057-63. doi: 10.1089/tmj.2013.0335.

***k* = 11: No intervention**

Carter MC, Burley VJ, Cade JE. Weight loss associated with different patterns of self-monitoring using the mobile phone app my meal mate. *Journal of Medical Internet Research* 2017; **5**(2): e8. doi: 10.2196/mhealth.4520.

Chung AE, Skinner AC, Hasty SE, Perrin EM. Tweeting to health: A novel mHealth intervention using fitbits and twitter to foster healthy lifestyles. *Clinical Pediatrics* 2017; **56**: 26-32. doi: 0.1177/0009922816653385.

Diouri O, Place J, Traverso M, Renard E. Development of a mobile application to compute food carbohydrates and first evaluation in patients with insulin-treated diabetes. *Diabetes Technology & Therapeutics* 2015; **17**: A24.

Gilliland J, Sadler R, Clark A, O'Connor C, Milczarek M, Doherty S. Using a smartphone application to promote healthy dietary behaviours and local food consumption. *BioMed Research International* 2015. doi: 10.1155/2015/841368.

Guo SHM, Chang HK, Lin CY. Impact of mobile diabetes self-care system on patients' knowledge, behavior and efficacy. *Computers in Industry* 2015; **69**: 22-29. doi: 10.1016/j.compind.2014.11.001.

Kerr DA, Harray AJ, Pollard CM, et al. The connecting health and technology study: A 6-month randomized controlled trial to improve nutrition behaviours using a mobile food record and text messaging support in young adults. *International Journal of Behavioral Nutrition and Physical Activity* 2016; **13**(52). doi: 10.1186/s12966-016-0376-8.

Mameli C, Brunetti D, Colombo V, et al. Combined use of a wristband and a smartphone to reduce body weight in obese children: randomized controlled trial. *Pediatric obesity* 2016; **13**(2): 81-87. doi: 10.1111/ijpo.12201.

Miller CK, Weinhold KR, Mitchell DC. Using Ecological Momentary Assessment to track goal progress toward the adoption of a low glycemic index diet among adults with type 2 diabetes: A pilot study. *Topics in Clinical Nutrition* 2016; **31**(4): 323-34. doi: 10.1097/TIN.0000000000000083.

Pretlow RA, Stock CM, Allison S, Roeger L. Treatment of child/adolescent obesity using the addiction model: A smartphone app pilot study. *Childhood Obesity* 2015; **11**(3): 248-59. doi: 10.1089/chi.2014.0124.

Turner-McGrievy GM, Davidson CR, Wilcox S. Does the type of weight loss diet affect who participates in a behavioral weight loss intervention? A comparison of participants for a plant-based diet versus a standard diet trial. *Appetite* 2014; **73**: 156-62. doi: 10.1016/j.appet.2013.11.008.

Ashman AM, Collins CE, Brown LJ, Rae KM, Rollo ME. A brief tool to assess image-based dietary records and guide nutrition counselling among pregnant women: An evaluation. *JMIR mHealth and uHealth* 2016; **4**(4): e123. doi: 10.2196/mhealth.6469.

k = 1: No nutrition related outcome targeted

Martin CK, Miller AC, Thomas DM, Champagne CM, Han H, Church T. Efficacy of Smart LossSM, a smartphone-based weight loss intervention: Results from a randomized controlled trial. *Obesity* 2015; **23**(5): 935-42. doi: 10.1002/oby.21063

k = 17: Abstract / proposal / statement

Adachi M, Fujimoto T. SDSS: Proposal on feeding support application software which enables the user to create a state of "mental alertness". In: Ito T (eds). *2015 IEEE/ACIS 14th International Conference on Computer and Information Science (ICIS)*. Piscataway, NJ: IEEE; 2015. pp. 513–518. doi: 10.1109/ICIS.2015.7166646.

Ainscough K, Kennelly M, Lindsay KL, O'Sullivan EJ, McAuliffe FM. Impact of an mHealth supported healthy lifestyle intervention on behavioural stage of change in overweight and obese pregnancy. *Proceedings of the Nutrition Society* 2016; **75**(OCE3): E85. doi: 10.1017/S0029665116001002.

Briassoulis G, Meyer R. A multidisciplinary mobile nutritional assessment model for family-supported dietary optimization in home-ventilated children. *Pediatric Critical Care Medicine* 2015; **16**(6): 596-98. doi: 10.1097/PCC.0000000000000457.

Khan DU. Design and evaluation of a mobile snack application for low socioeconomic status families. *Computer Science Graduate Theses & Dissertations* 2013; 78.

Spring B, Pellegrini CA, McFadden HG, Pfammatter A, Siddique J, Hedeker D. Clinical trial of a mobile health intervention for simultaneous versus sequential diet and activity change. *Circulation* 2015; **132**(23): 2270.

Struempler B, Parmer SM, Funderburk K. Use of blended learning to improve nutrition knowledge in third-graders. *Journal of Nutrition Education & Behavior* 2016; **48**(7): 510-11.e1. doi: 10.1016/j.jneb.2016.04.401.

Watterson T. Changes in attitudes and behaviors toward physical activity, nutrition, and social support for middle school students using the AFIT app as a supplement to instruction in a physical education class. *Graduate Theses and Dissertations* 2012.

Bender MS, Cooper B, Arai S. A feasible and effective mobile health weight loss öifestyle intervention for filipinos with type 2 diabetes. *Circulation* 2017; **135**(10).

Fukuoka Y, Gay C, Joiner K, Vittinghoff E. A novel mobile phone delivered diabetes prevention program in overweight adults at risk for type 2 diabetes – A randomized controlled trial. *Circulation* 2014; **130**(2).

Goad K. My No-Diet Solution. *Health* 2011; **25**(5): 59.

Johnston C, Thompson-Felty C. Adherence to daily diet monitoring using one of three commercial diet apps via smartphones was associated with significant weight loss in healthy overweight adults irrespective of the diet app. *Fasebility Journal* 2015; **29**(1): 597-8.

Kaipainen K. *Design and evaluation of online and mobile applications for stress management and healthy eating*. Tampere, Finnland; 2014.

Mosqueda MI, Martinez CL, Orr BJ, Merchant NC, Going SB, Hongu N. A nutrition and physical activity intervention using smart phones in physical education classes at a junior high school. *Fasebility Journal* 2012; **26**(1): 257.

Steinbach P. Sooner in life. *Athletic Business* 2011; **35**: 61-62.

Webster ST. Beat holiday pounds with a few ounces of prevention. *IDEA Food and Nutrition Tips* 2012; **1**(7).

Widmer RJ, Allison TG, Lopez-Jimenez F, Lennon R, Lerman LO, Lerman A. digital health intervention during cardiac rehabilitation reduces emergency department visits and improves weight loss: A randomized controlled trial. *Circulation* 2016; **134**(1).

Xu CH, Zhu J, Li ZX, Xiao J, Huang CQ, Tang Y. SHMS: A Smartphone self-health management system using data mining. In: Cui B, Zhang N, Xu J, Lian X, Liu D (eds.). *Web-Age Information Management, Pt II* 2016; 521-23.

***k* = 2: Insufficient data/method for assessing eating behavior in app**

Elbert SP, Dijkstra A, Oenema A. A mobile phone app intervention targeting fruit and vegetable consumption: The efficacy of textual and auditory tailored health information tested in a randomized controlled trial. *Journal of Medical Internet Research* 2016; **18**(6): e147. doi: 10.2196/jmir.5056.

Du H, Venkatakrishnan A, Youngblood GM, Ram A, Pirolli P. A group-based mobile application to increase adherence in exercise and nutrition programs: A factorial design feasibility study. *JMIR mHealth and uHealth* 2016; **4**(1): e4. doi: 10.2196/mhealth.4900.

Supporting Information 4

CONSORT 2010 checklist[50] with definitions

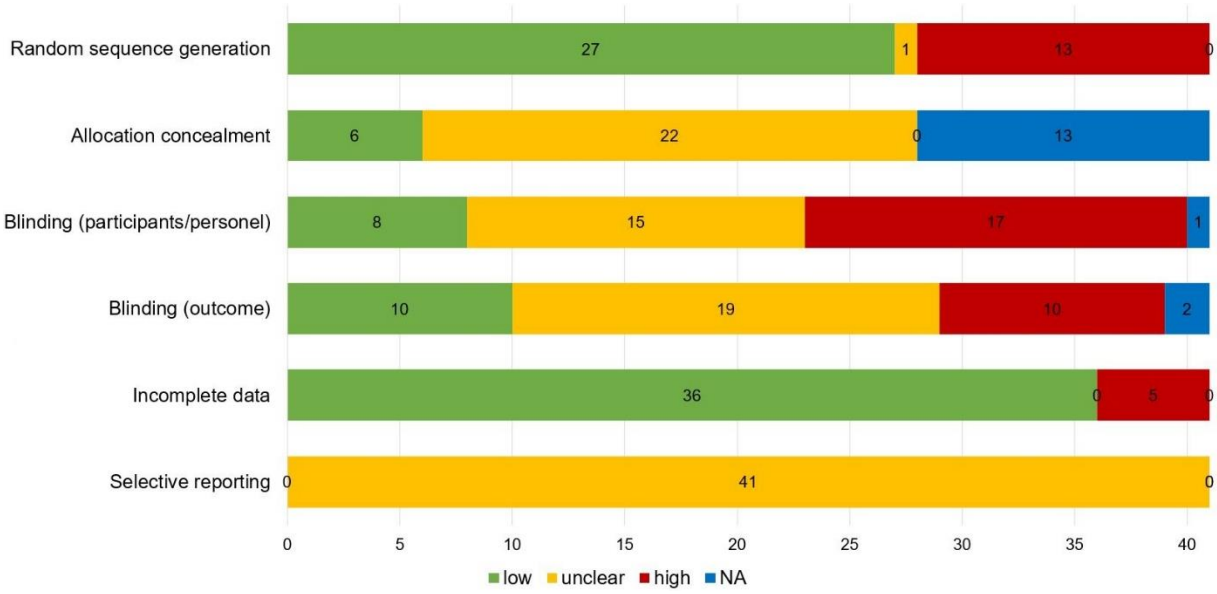
All items were coded in duplicate by two independent reviewers with 0 = item not fulfilled, 0.5 = item only partially fulfilled, 1 = item fulfilled, NA = not applicable to the study.

#	Item	Definition
Title and Abstract		
1a		Identification as a randomized trial in the title
1b		Structured summary of trial design, methods, results, and conclusions
Introduction		
2a	Background & objectives	Scientific background and explanation of rationale
2b		Specific objectives or hypotheses
Methods		
3a	Trial design	Description of trial design (such as parallel, factorial) including allocation ratio
3b		Important changes to methods after trial commencement (such as eligibility criteria), with reasons
4a	Participants	Eligibility criteria for participants
4b		Settings and locations where the data were collected
5	Interventions	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered
6a	Outcomes	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed
6b		Any changes to trial outcomes after the trial commenced, with reasons
7a	Sample size	How sample size was determined
7b		When applicable, explanation of any interim analyses and stopping guidelines
8a	Random sequence generation	Method used to generate the random allocation sequence
8b		Type of randomization; details of any restriction (such as blocking and block size)
9	Allocation concealment	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned
10	Implementation	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions
11a	Blinding	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how
11b		If relevant, description of the similarity of interventions

12a	Statistical methods	Statistical methods used to compare groups for primary and secondary outcomes
12b		Methods for additional analyses, such as subgroup analyses and adjusted analyses
Results		
13a	Participant flow	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome
13b		For each group, losses and exclusions after randomization, together with reasons
14a	Recruitment	Dates defining the periods of recruitment and follow-up
14b		Why the trial ended or was stopped
15	Baseline data	A table showing baseline demographic and clinical characteristics for each group
16	Numbers analysed	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups
17a	Outcomes and estimation	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)
17b		For binary outcomes, presentation of both absolute and relative effect sizes is recommended
18	Ancillary analyses	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory
19	Harms	All important harms or unintended effects in each group
Discussion		
20	Limitations	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses
21	Generalizability	Generalizability (external validity, applicability) of the trial findings *Note. 1=mentioned and given, 0.5=mentioned and not given, 0=not mentioned*
22	Interpretation	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence
Other information		
23	Registration	Registration number and name of trial registry
24	Protocol	Where the full trial protocol can be accessed, if available *Note. 1=available & accessible, 0=available but not accessible, NA=no protocol mentioned/available*
25	Funding	Sources of funding and other support (such as supply of drugs), role of funders

Supporting Information 5

Cochrane risk of bias[53, 55] assessment across studies



Supporting Information 6

Cochrane risk of bias[53, 55] assessment for each study

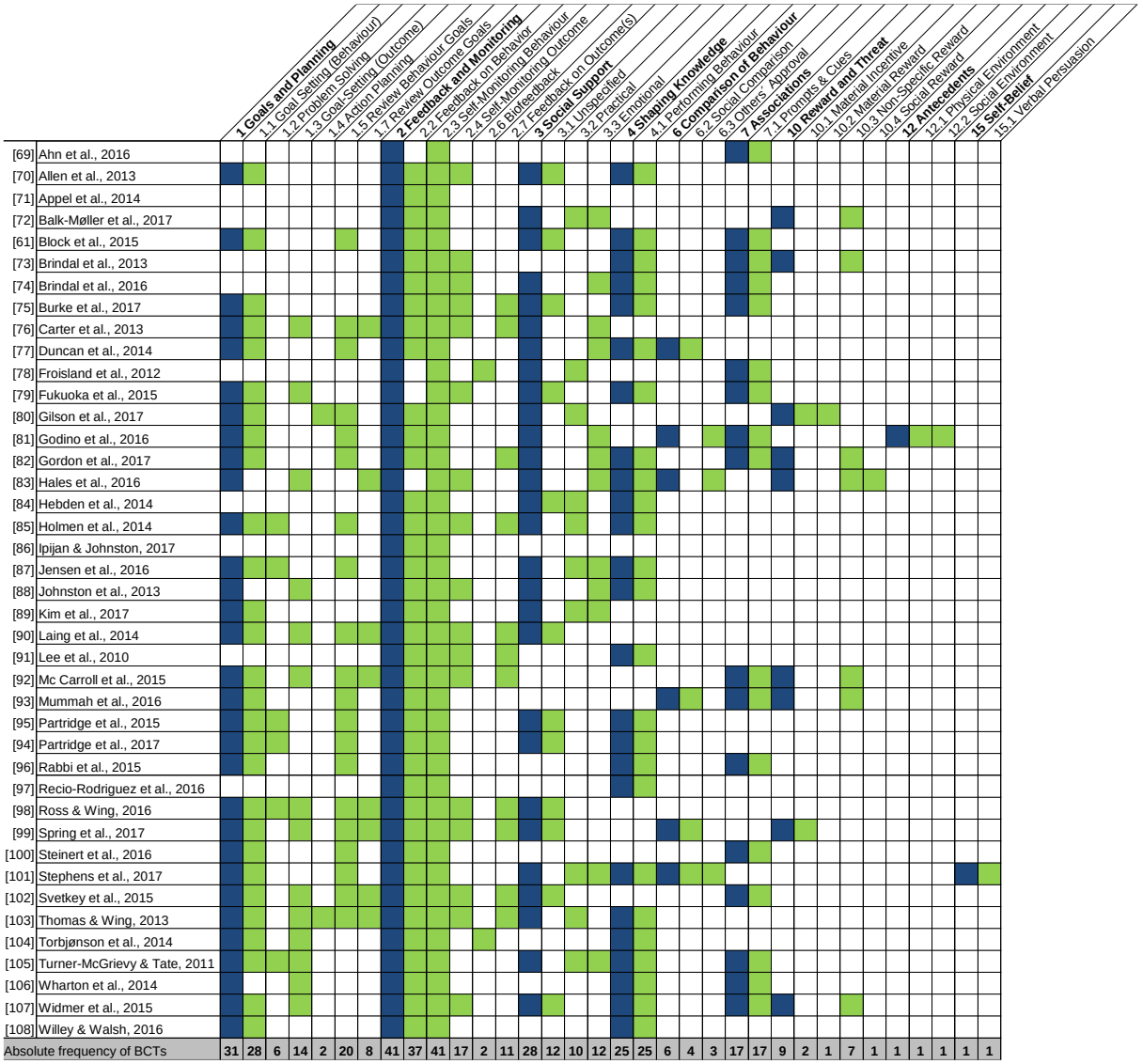
(H = high risk, U = unclear risk, L = low risk, NA = not applicable).

Study	Random seq. generation	All. concealment	Blinding (part./pers.)	Blinding (outcome)	Incomplete data	Selective reporting
[69] Ahn et al., 2016	H	NA	U	U	L	U
[70] Allen et al., 2013	L	U	U	U	L	U
[71] Appel et al., 2014	H	NA	H	U	H	U
[72] Balk-Møller et al., 2017	L	L	H	H	L	U
[61] Block et al., 2015	L	L	H	L	L	U
[73] Brindal et al., 2013	L	U	L	H	L	U
[74] Brindal et al., 2016	L	U	U	U	L	U
[75] Burke et al., 2017	L	U	U	U	L	U
[76] Carter et al., 2013	L	U	H	L	L	U
[77] Duncan et al., 2014	L	U	L	L	L	U
[78] Froisland et al., 2012	H	NA	H	H	L	U
[79] Fukuoka et al., 2015	L	L	H	L	L	U
[80] Gilson et al., 2017	H	NA	H	U	H	U
[81] Godino et al., 2016	L	L	H	L	L	U
[82] Gordon et al., 2017	H	NA	U	U	L	U
[83] Hales et al., 2016	L	U	H	H	L	U
[84] Hebden et al., 2014	L	U	L	H	L	U
[85] Holmen et al., 2014	L	U	H	H	L	U
[86] Ipijan & Johnston, 2017	L	U	U	U	L	U
[87] Jensen et al., 2016	H	NA	H	U	H	U
[88] Johnston et al., 2013	L	U	U	U	L	U
[89] Kim et al., 2017	H	NA	NA	U	L	U
[90] Laing et al., 2014	L	L	L	H	H	U
[91] Lee et al., 2010	H	NA	H	U	L	U
[92] Mc Carroll et al., 2015	H	NA	U	U	H	U
[93] Mummah et al., 2016	L	U	L	L	L	U
[95] Partridge et al., 2015	L	L	L	L	L	U
[94] Partridge et al., 2017	U	U	L	U	L	U
[96] Rabbi et al., 2015	L	U	L	H	L	U
[97] Recio-Rodriguez et al., 2016	L	U	H	L	L	U
[98] Ross & Wing, 2016	L	U	H	L	L	U
[99] Spring et al., 2017	L	U	H	L	L	U
[100] Steinert et al., 2016	H	NA	U	U	L	U
[101] Stephens et al., 2017	L	U	U	U	L	U
[102] Svetkey et al., 2015	L	U	U	U	L	U
[103] Thomas & Wing, 2013	H	NA	U	NA	L	U
[104] Torbjønson et al., 2014	L	U	H	H	L	U
[105] Turner-McGrievy & Tate, 2011	L	U	H	H	L	U
[106] Wharton et al., 2014	L	U	U	U	L	U
[107] Widmer et al., 2015	H	NA	U	U	L	U
[108] Willey & Walsh, 2016	H	NA	U	NA	L	U

Note. Criterion for assessment of "*incomplete outcome data*": high = >25%, low = <25% or intention-to-treat analysis, unclear = no data provided.

Supporting Information 7

Behaviour Change Techniques (BCTs) for each study



Note. Blue coloured squares represent the presence of the respective BCT cluster; green coloured squares the presence of a single BCT.

Supporting Information 8

Detailed description of included studies and analysed outcomes

Legend. [1] * = groups were pooled and combined; [x] = groups were excluded from analysis; [+] = groups were analysed separately, [2] [$]app available for download. For outcomes in **bold** separate analyses are reported. Outcomes in *Italic* are pooled in the analyses of nutrition behaviours and nutrition-related health outcomes.

Review										**Meta-analysis**		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups[1]**	**App[2]**	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Ahn et al., 2016 [69]	Control group design	2 groups: (1) Web-based u-Health-program (2) Control group	Diabetes Mellitus Dietary Manage-ment Guide, DMDMG	26	Diabetes patients (1) M_{age} = 50.5 (*SD* = 17.1); (2) M_{age} = 49.7 (*SD* = 16.4)	Development of a mobile nutritional management program for integration into the web-based program for diabetic patients.	App only	2 months (1 month intervention)	Anthropometric measures, nutrients, effectiveness of program	**Caloric intake (kcal)** *Dietary pattern (study specific score), carbohydrates, lipids, protein, vitamin A, vitamin B, vitamin C, vitamin B1, vitamin B2, vitamin B6, niacin, pholic acid, CA, P, FE, NA, K*	**Body weight** **BMI**	20
Allen et al., 2013 [70]	RCT	4 groups: (1) Intensive counselling (2) Intensive counselling plus smartphone* (3) Less intensive counselling plus smartphone * (4) Smartphone*	LoseIt![$]	68 (43 after drop-out)	Obese participants M_{age} = 44.9 (*SD* = 11.1); M_{BMI} = 34.3 (*SD* = 3.9)	Evaluation of feasibility, acceptability, and preliminary efficacy of theoretically-based behavioural interventions delivered by smartphone technology.	App + nutrition counselling	6 months (study and intervention)	Weight, BMI, waist circumference Diet, physical activity	**Caloric intake (kcal)** **Fruit/vegetable intake** *Sodium*	**Body weight** **BMI**	5

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Appel et al., 2014 [71]	Control group design	2 groups: (1) App group (2) Control group	LoseIt![$]	421 (118 after pre-survey)	Ethnically diverse and low-income participants M_{age} = 15.9 (*SD* = 1.3); M_{BMI} = 23.9 (*SD* = 4.9)	Test an intervention for childhood obesity using a free smartphone app with the primary aim of assessing students' knowledge of nutritional indicators, physical exercise and use of screen time.	App only	20 days (study and intervention)	Physical activity, screen time, type of food, height, weight, nutrition knowledge		**BMI**	1
Balk-Møller et al., 2017 [72]	RCT	2 groups: (1) SoSu group (2) Control group	SoSu-life	566 (269 after drop-out)	Nursing home employees; (1) M_{age} = 47 (*SD* = 10.0); (2) M_{age} = 47 (*SD* = 9.9)	Test a web- and mobile app-based tool ('SoSu-life') on employees in the social welfare and health care sector in Denmark.	App only	38 weeks (study and intervention)	Weight Body fat, waist circumference, blood pressure, cholesterol, well-being		**Body weight** **Cholesterol** *Body fat, waist circumference, systolic blood pressure, diastolic blood pressure*	6
Block et al., 2015 [61]	RCT	2 groups: (1) Alive-PD (2) Waitlist as control	Alive-PD[$]	339 (292 after drop-out)	Prediabetic adults M_{age} = 55 (*SD* = 8.9)	Evaluate the effectiveness of a fully automated algorithm-driven behavioural intervention for diabetes prevention.	App + weekly e-mails, individual web page, automated phone calls	12 months (study and intervention but with less intensive intervention in last 6 months)	Glucose Weight, BMI, waist circumference, triglyceride/ HDL ratio, Framingham diabetes risk score		**Body weight** **BMI** *Waist circumference, fasting glucose, HbA1c, triglyceride/ HDL ratio*	6

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Brindal et al., 2013 [73]	RCT	2 groups: (1) MRP support app (2) Static app based on information in MRP	Meal Replace-ment Program, MRP	58 (44 after drop-out)	Adult women with BMI > 25 M_{age} = 42 (range: 19-63); M_{weight} = 92.4 kg (SD = 14.7); M_{BMI} = 34 (range: 26-43)	Development and evaluation of a weight-loss intervention delivered by an evidence-based smartphone app that supported individuals embarking on a diet.	App only	2 months (study and intervention)	User interaction App evaluation, mood, motivation, weight, dietary compliance	*Dietary pattern (Meal replacement)*	**Body weight**	2
Brindal et al., 2016 [74]	RCT	2 groups: (1) MRP support app (2) Static app based on information in MRP	Meal Replace-ment Program, MRP	146 (84 after drop-out)	Overweight and obese adults M_{age} = 48.18 (SD = 11.75)	Design and evaluate a weight-loss program, including a partial MRP, point-of-care testing and face-to-face and smartphone app support, appropriate for delivery in a community pharmacy setting.	App + MRP	6 months (3 months intervention)	Weight, blood pressure, glucose and blood lipids Self-efficacy, physical activity, feedback		**Body weight** **Cholesterol** *Systolic blood pressure, diastolic blood pressure, glucose, triglyceride, HDL, LDL*	8

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Burke et al., 2017 [75]	RCT	3 groups: (1) LoseIt smartphone app* (2) App+ feedback* (3) App + feedback + in-persons group sessions*	LoseIt![$]	39 (29 after drop-out)	Obese or overweight adults M_{age} = 44.84 (*SD* = 12.75); M_{BMI} = 33.76 (*SD* = 4.28)	Test the feasibility of providing 1-4 daily messages tailored to dietary recordings via smartphone.	App + feedback messages, group sessions	3 months (study and intervention)	Recruitment, retention, adherence, weight Blood pressure, self-efficacy		**Body weight**	1
Carter et al., 2013 [76]	RCT	3 groups: (1) Mobile (2) Website* (3) Diary group*	My Meal Mate (MMM)[$]	128 (79 after drop-out)	Overweight adults (1) M_{age} = 41.2 (*SD* = 8.5); M_{BMI} = 33.7 (*SD* = 4.2) (2) M_{age} = 41.9 (*SD* = 10.6); M_{BMI} = 34.5 (*SD* = 5.6) (3) M_{age} = 42.5 (*SD* = 8.3); M_{BMI} = 34.5 (*SD* = 5.7)	Collect acceptability and feasibility outcomes of a self-monitoring weight management intervention delivered by a smartphone app.	App only	6 months (study and intervention)	Feasibility and acceptability Height, weight, BMI, body fat, demographics, physical activity, eating behaviour		**Body weight** **BMI** *Body fat*	3

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Duncan et al., 2014 [77]	RCT	2 groups: (1) Print-based (2) IT-based	ManUp	301 (148 after drop-out)	Adult males (1) M_{age} = 43.8 (SD = 0.6) (2) M_{age} = 44.2 (SD = 0.4)	Examine the effectiveness of an IT-based intervention to improve physical activity, dietary behaviors, and health literacy compared to a print-based intervention.	App only	9 months (study and intervention)	Physical activity, dietary behaviour, health literacy, satisfaction, IT platform usage	*Dietary pattern (study specific score)* *High-fibre bread, low-fat milk consumption*		3
Frøisland et al., 2012 [78]	Pre-post design	1 group testing two apps	Diambo, unnamed app	12 (11 after drop-out)	Adolescents, Diabetes Type 1 M_{age} = 16.2 (SD = 1.7); M_{BMI} = 23.3 (SD = 3.2)	Explore how mobile phone applications can be used in follow-up of adolescents with type 1 diabetes, and use the findings to development these applications further.	App + counselling and reflection	3 months (study and intervention)	HbA1C, glycaemic control, usability, knowledge tests		HbA1c	1
Fukuoka et al., 2015 [79]	RCT	2 groups: (1) Intervention (2) Control	Mobile Diabetes Prevention Program, mDPP	61 (56 after drop-out)	Adults with risk of Type 2 Diabetes M_{age} = 55.3 (SE = 9); M_{BMI} = 33.3 (SE = 6)	Examine the feasibility and efficacy of a diabetes prevention intervention combined with a mobile app and pedometer.	App + in-person sessions	5.5 months (5 months intervention)	Weight, BMI Hip circumference, blood pressure, lipids, glucose, physical activity, caloric, SSB, fat intake, social support, self-efficacy, depression	**Caloric intake (kcal)** *Fat, saturated fat, SSB consumption*	**Body weight** **BMI** **Cholesterol** *Hip circumference, systolic blood pressure, diastolic blood pressure, glucose, triglyceride, HDL, LDL*	14

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Gilson et al., 2017 [80]	Pre-post design	1 group	Jawbone Up[$]	26 (19 after drop-out)	Male Australian truck drivers M_{age} = 44.4 (*SD* = 10); M_{BMI} = 31.2 (*SD* = 4.6)	Examine the extent to which an m-Health financial incentive program facilitated physical activity and healthy dietary choices.	App + feedback, guidance and monetary reward	7 months (5 months intervention)	Physical activity Sedentary time, fruit/vegetable intake, fat, sugar	**Fruit intake** **Vegetable intake** *Saturated fat, sugar*		4
Godino et al., 2016 [81]	RCT	2 groups: (1) SMART intervention (2) Control group	GoalGetter App, BeHealthy App, Trend Setter App	404 (355 after drop-out)	Young adults M_{age} = 22.7 (*SD* = 3.8) (1) M_{BMI} = 28.9 (*SD* = 2.8) (2) M_{BMI} = 29 (*SD* = 2.7)	Assess the efficacy of a 2-year theory-based weight-loss intervention delivered via integrated user experiences.	App + Facebook, text messaging, emails, website, technology-mediated communication with a health coach	24 months	Weight BMI, waist/ arm circumference, blood pressure, heart rate, use of intervention components		**Body weight** **BMI** *Waist circumference, arm circumference, systolic blood pressure, diastolic blood pressure, heart rate*	7
Gordon et al., 2017 [82]	Pre-post design	1 group	See Me Smoke-Free™	73 (66 after drop-out)	Smoking women M_{age} = 39.1 (*SD* = 13.1)	Develop and test the feasibility and potential of the See Me Smoke-Free™ m-Health app to address smoking, diet, and physical activity among women smokers.	App only	3 months (30 days intervention)	Physical activity, fruit, vegetable, juice intake, smoking, tobacco use, weight, body image, craving, withdrawal, app satisfaction, acceptability	**Fruit intake** **Vegetable intake** *Juice consumption*	**Body weight**	4

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Hales et al., 2016 [83]	RCT	2 groups: (1) Social POD app+ (2) Standard app+	Social POD App	51 (42 after drop-out)	Overweight adults M_{age} = 46.2 (*SD* = 12.4) M_{BMI} = 34.7 (*SD* = 6.0)	Test the efficacy of a weight loss mobile app based on recommender systems to target social support and self-monitoring of diet, physical activity, and weight, compared to a commercially-available diet and physical activity tracking app.	App + podcasts	3 months (study and intervention)	Weight BMI, caloric intake, expenditure, social support, self-efficacy, outcome expectations	**Caloric intake (kcal)**	**Body weight** **BMI**	3
Hebden et al., 2014 [84]	RCT	2 groups: (1) Intervention (2) Control	m-Health program	51 (46 after drop-out)	(1) M_{age} = 22.6 (*SD* = 5.4); M_{BMI} = 27.3 (2) M_{age} = 23.1 (*SD* = 3.7); M_{BMI} = 27.2	Measure the effect of a m-Health intervention program on body weight, BMI and specific lifestyle behaviours.	App + SMS, e-mails, internet forum, guidance of investigator	13 weeks (12 weeks intervention)	Weight, BMI Sitting time, physical activity, SSB intake, energy-dense takeaway meals, fruit and vegetables	**Fruit intake** **Vegetable intake** *SSB consumption*	**Body weight** **BMI**	5

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Holmen et al., 2014 [85]	RCT	3 groups: (1) FTA (2) FTA +health counselling[x] (3) Control group	Few Touch Applica-tion, FTA	151 (120 after drop-out)	Overweight adults age range: 18 - 35; BMI range: 24 - 32	Test whether the use of a mobile phone-based self-management system, with or without telephone health counselling, could improve glycated haemoglobin A1c level, self-management, and health-related quality of life.	App only	1 year (study and intervention)	HbA1c level Self-management, lifestyle, dietary habits, physical activity, depressive symptoms, weight		**Body weight** *HbA1c*	2
Ipjian & Johnston, 2017 [85]	RCT	2 groups: (1) MyFitnessPal App (2) Writing journal	MyFitness Pal[$]	30	Adults M_{age} = 34.4 (*SD* = 15.7) (1) M_{BMI} = 25.3 (*SD* = 4.9) (2) M_{BMI} = 25.9 (*SD* = 3.7)	Reducing sodium intake to determine whether a commercial health app is useful for promoting dietary change.	App only	1 month (study and intervention)	Sodium intake, dietary quality score, blood pressure, weight, body fat, waist circumference	*Dietary pattern (Rapid Eating and Activity Assessment for Participants - short version, REAP-S), sodium*		2

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Jensen et al., 2016 [87]	Pre-post design	1 group in two different phases (3 months combined treatment followed by 3 months electronic treatment)	Daily Burn Tracker[$]	16 (10 after drop-out)	Overweight or obese adolescents M_{age} = 14.3 (*SD* = 1.1)	Examine the efficacy and acceptability of a smartphone assisted adolescent behavioural weight control intervention.	App + group and family weight loss program, text messages	1 year (2 intervention periods of 3 months each)	BMI, weight, satisfaction with intervention Feasibility of intervention		**Body weight** **BMI**	2
Johnston et al., 2013 [88]	RCT	2 groups: (1) Weight Watchers (2) Self-help control group	Weight Watchers App[$]	292 (257 after drop-out)	Obese or overweight adults M_{age} = 46.5 (*SD* = 10.5); M_{BMI} = 33 (*SD* = 3.6)	Examine weight loss between a community-based, intensive behavioural counselling program and a self-help condition.	App + weekly meetings, online tools	6 months (study and intervention)	Weight, BMI Attendance, mobile device application usage, use of access points		**Body weight** **BMI**	2
Kim et al., 2017 [89]	Online survey	1 group	Noom[$]	384	Adults and adolescents using Noom M_{age} = 34.4 (*SD* = 10.6); M_{BMI} = 30.6 (*SD* = 6.5)	Examine the use of a weight loss app to elucidate how it can help individuals harness the power of self-efficacy and group support to enact behaviour change and accomplishment of health goals.	App only	One-time assessment but extracted data from 6 months	Self-efficacy, behavioural variables, weight, BMI		**Body weight** **BMI**	2

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Laing et al., 2014 [90]	RCT	2 groups: (1) Usual primary care + app (2) Usual primary care	MyFitness Pal[$]	212 (158 after drop-out)	Overweight or obese adults M_{age} = 43.1 (*SD* = 14) (1) M_{BMI} = 33.3 (*SD* = 6.8) (2) M_{BMI} = 33.3 (*SD* = 7.2)	Evaluate the impact of introducing patients to a popular, free smartphone app for weight loss in a primary care setting	App only	6 months (study and intervention)	Weight Blood pressure, physical activity, healthy diet, calorie goals, self-efficacy	*Dietary pattern (two study specific score)*	**Body weight** *Systolic blood pressure*	4
Lee et al., 2010 [91]	Case-control design	2 groups: (1) Intervention group (2) Informed control group	The SmartDiet	36	Volunteers from an obesity clinic; (1) M_{age} = 28.2; M_{BMI} = 22.2 (2) M_{age} = 29.5; M_{BMI} = 22.3	Evaluate the effectiveness of the mobile phone application with respect to acquiring dietary information, weight control, and user satisfaction.	App only	6 weeks (study and intervention)	Body composition, physical activity, regularity of eating, smoking, drinking		**Body weight** **BMI** *Body fat mass*	3

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Mc Carroll et al., 2015 [92]	Pre-post design	1 group	LoseIt![$]	50 (35 after drop-out)	Endometrial and breast cancer survivors M_{age} = 58.4 (*SD* = 10.3); M_{BMI} = 36.4 (*SD* = 8.1)	Assess a one-month lifestyle intervention delivered via a web- and mobile-based weight-loss application using a healthcare-provider interface.	App + nutrition and weight goal set at baseline, phone calls, e-mail notifications	1 month (study and intervention)	Weight, BMI, waist circumference Physical activity, caloric intake and nutritional content	**Caloric intake (kcal)** *Carbohydrates, fat, protein, fibre*	**Body weight** **BMI** *Waist circumference*	8
Mummah et al., 2016 [93]	RCT	2 groups: (1) Intervention (2) Wait-list control condition	Vegethon	17 (12 after drop-out)	Overweight adults M_{age} = 42 (*SD* = 7.3); M_{BMI} = 32 (*SD* = 3.5)	Assess the initial efficacy and user acceptability of a theory-driven mobile app to increase vegetable consumption.	App only	3 months (intervention app at least 6 weeks)	Vegetable consumption	**Vegetable intake** (all vegetables, green leafy vegetables, cruciferous vegetables, dark yellow vegetables, tomatoes, other vegetables, beans/lentils)		7

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Partridge et al., 2015 [95]	RCT	2 groups: (1) Intervention group (2) Control group	TXT2BFit	248 (214 after drop-out at 12 weeks)	(1) M_{age} = 28.1 (*SD* = 4.9); M_{BMI} = 27.3 (*SD* = 2.4) (2) M_{age} = 27.2 (*SD* = 4.9); M_{BMI} = 27.1 (*SD* = 2.7)	Design and assess the efficacy of a m-Health prevention program in preventing excess weight gain and improving dietary and physical activity behaviours in young adults at increased risk of obesity and unhealthy lifestyle choices.	App + coaching calls, text messages, e-mails	3 months (study and intervention)	Weight, BMI Physical activity, fruit and vegetable intake, SSB, energy-dense takeout meals		**Body weight** **BMI**	2
Partridge et al., 2017 [94]	RCT	2 groups: (1) Intervention group (2) Control group	TXT2BFit	248 (202 after drop-out at 9 month)	Young adults at risk of weight gain age range: 18 - 35; BMI range: 21 - 32	Assess the intervention effects on knowledge, self-efficacy and stage-of-change for four target lifestyle behaviours, and investigate the mediating effects of self-efficacy on those lifestyle behaviours in the weight gain prevention intervention.	App + coaching calls, text messages, e-mails, study website, booklet	9 months (3 months intervention)	Fruit and vegetable knowledge, self-efficacy, diet (stage of change for fruit, vegetables, SSB, take-away meals), physical activity	**Fruit intake** **Vegetable intake** *SSB, take-away meal consumption*		4

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Rabbi et al., 2015 [96]	RCT	2 groups: (1) Intervention group with personalized suggestions (2) Control group	My Behaviour	18 (17 after drop-out)	Adults M_{age} = 28.3 (*SD* = 7.0)	Technical feasibility on implementing an automated feedback system, the impact of the suggestions on user physical activity and eating behaviour, and user perceptions of the automatically generated suggestions.	App only	3 weeks (2 weeks intervention)	Dietary behaviour, physical activity	**Caloric intake (kcal)**		1
Recio-Rodriquez et al., 2016 [97]	RCT	2 groups: (1) App + counselling group (2) Counselling only group	unclear	833 (765 after drop-out)	(1) M_{age} = 51.4 (*SD* = 12.1); M_{BMI} = 28.1 (*SD* = 5.1) (2) M_{age} = 52.3 (*SD* = 12); M_{BMI} = 27.6 (*SD* = 4.6)	Evaluate the effect of adding an app to standard counselling on increased physical activity and adherence to the Mediterranean diet, 3 months after implementation.	App + counselling in physical activity and Medi-terranean diet, one in-between visit	12 months (3 months intervention)	Physical activity, Mediterranean diet score Blood pressure, waist circumference, BMI, laboratory parameters	*Dietary pattern (Mediterranean diet according to MEDAS - Mediterranean Diet Adherence Screener)*		1

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Ross & Wing, 2016 [98]	RCT	3 groups: (1) Standard tool (2) Technology-based tool* (3) Technology-based tool combined with phone-based intervention*	FitBit Smart-phone App[$]	80 (72 after drop-out)	Overweight and obese adults M_{age} = 51.1 (*SD* = 11.7); M_{BMI} = 33.0 (*SD* = 3.4)	Examine efficacy of self-monitoring technology, with and without phone-based intervention, on 6-month weight loss in overweight and obese adults.	App + in person "weight loss 101" session	6 months (study and intervention)	Weight Adherence to self-monitoring		**Body weight**	1
Spring et al., 2017 [99]	RCT	3 groups: (1) Self-guided[x] (2) Standard (3) Technology supported	ENGAG-ED	96 (83 after drop-out)	Overweight or obese adults M_{age} = 39.3 (*SD* = 11.7); M_{BMI} = 34.6 (*SD* = 3)	Determine the effects on weight loss of three abbreviated behavioural weight loss interventions with and without coaching and mobile technology.	App + weight loss target, kcal goal, team competition, financial incentive, group sessions	12 months (6 months intervention)	Weight Behavioural adherence		**Body weight**	1

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Steinert et al., 2016 [100]	Pre-post design	1 group	MyTher-apy[$]	30	M_{age} = 68 (range: 61-76); 15 females with M_{BMI} = 27.7 (range: 24-35); 15 males with M_{BMI} = 27.3 (range: 22.5-34)	Identify the benefit of self-monitoring with a smartphone application for adults.	App only	5 weeks (4 weeks intervention)	Recreational and physical activity, weight, water control, nutrition, medication intake	**Fruit intake** *Fish consumption*	**Body weight**	3
Stephens et al., 2017 [101]	RCT	2 groups: (1) Intervention group with app + health coach + counselling (2) Only counselling control group	LoseIt![$]	62 (59 after drop-out)	Young adults age range: 18 - 25; M_{BMI} = 28.5	Effectiveness of a behaviour-based smartphone application for weight loss, combined with text messaging from a health coach on weight, body mass index, and waist circumference in young adults in comparison with a control condition.	App + baseline counselling sessions, specific goal setting, text messages from health coach	3 months (study and intervention)	Weight, BMI, waist circumference Diet, physical activity, self-efficacy	**Fruit intake** **Vegetable intake** **Caloric intake (kcal)** *Carbohydrates, protein, fat, saturated fat, sugar, added sugar, fibre, sodium, dairy product consumption*	**Body weight** **BMI** *Waist circumference*	15

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Svetkey et al., 2015 [102]	RCT	3 groups: (1) App group (2) Personal coaching enhanced by smartphone self-monitoring[x] (3) Control	unclear	365 (313 after drop-out)	Young overweight or obese adults M_{age} = 29.4 (*SD* = 4.3); M_{BMI} = 35.2 (*SD* = 7.8)	Determine the effect on weight of two mobile technology-based behavioural weight loss interventions in young adults.	App only	2 years (study and intervention)	Weight Weight changes in sub-groups, Healthy Eating Index	*Dietary pattern (Healthy Eating Index, HEI-2005)*	**Body weight**	2
Thomas & Wing, 2013 [103]	Pre-post design	1 group	Health-E-Call and DailyBurn[$]	20 (15 for 2nd period)	Overweight or obese adults M_{age} = 53.0 (*SD* = 1.9); M_{BMI} = 36.3 (*SE* = 1.2)	Evaluate smartphones as a method of delivering key components of established and empirically validated behavioural weight loss treatment, with an emphasis on adherence to self-monitoring.	App + individual goal setting sessions, SMS, in-person weigh-ins, paper lessons	6 months (at least 3 months intervention with additional treatment at 6 months)	Weight, adherence to self-monitoring protocol Satisfaction with program		**Body weight**	1

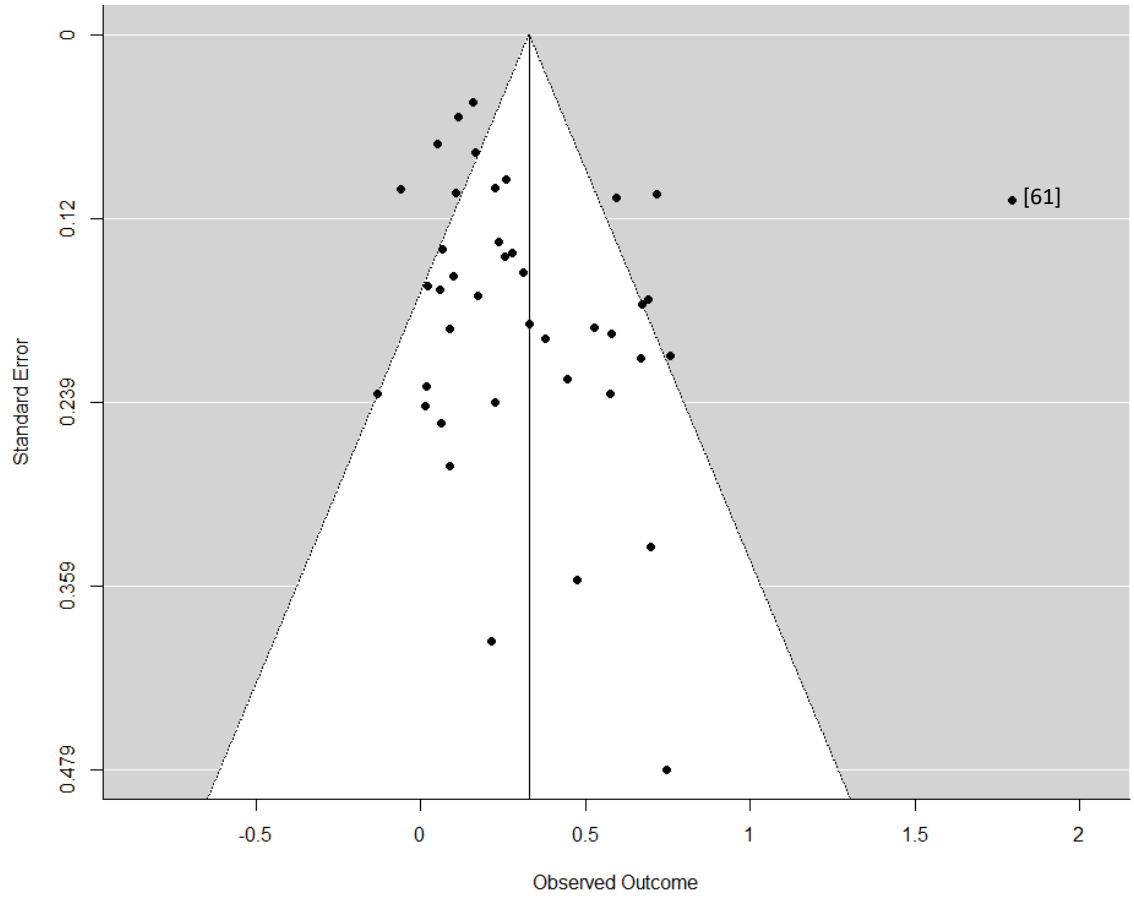
Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Torbjøns. et al., 2014 [104]	RCT	3 groups: (1) FTA intervention (2) FTA+health counselling intervention[x] (3) Usual care control group	Few Touch Appli-cation, FTA	151 (129 after drop-out)	Adults with type 2 diabetes M_{age} = 57 (*SD* = 12); M_{BMI} = 31.7 (*SD* = 6.0)	Evaluate whether the introduction of technology-supported self-management using the FTA diabetes diary, with or without health counselling, improved HbA1c levels, self-management, behavioural change, and quality of life.	App only	1 year (study and intervention, but only 4 months follow-up included in paper)	HbA1c Self-management, behaviour change, health-related quality of life		*HbA1c*	1
Turner-M.&Tate, 2011 [105]	RCT	2 groups: (1) Podcast mobile group (2) Podcast	FatSecret's Calorie Counter app (version 2010)[$] + Twitter app[$]	96 (86 after drop-out)	Overweight adults age range: 18-60; M_{BMI} = 32.6 (range: 25-45)	Examine whether a combination of podcasting, mobile support communication, and mobile diet monitoring can assist people in weight loss.	App + Twitter, podcasts, messages from study coordinator	6 months (study and intervention)	Weight Diet, physical activity, psychosocial measures, user control, elaboration, evaluation	**Caloric intake (kcal)** *Dietary pattern (Eating Behaviour Inventory, EBI), fat*	**Body weight**	4

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Wharton et al., 2014 [106]	Control group design	3 groups: (1) App (2) Memo function* (3) Paper pencil*	LoseIt![$]	57 (47 after drop-out)	Adults aged 18-65 (1) M_{age} = 43.7 (*SD* = 3.5); M_{BMI} = 29.9 (*SD* = 0.9) (2) M_{age} = 41.5 (*SD* = 4.0); M_{BMI} = 31.0 (*SD* = 1.7) (3) M_{age} = 40.8 (*SD* = 3.8); M_{BMI} = 28.9 (*SD* = 1.0)	Test the use of a popular smartphone app for dietary self-monitoring and weight loss by comparing it with traditional diet counselling and entry methods.	App + nutrition counselling, messages	8 weeks (study and intervention)	Dietary intake, weight, BMI, attrition		**Body weight**	1
Widmer et al., 2015 [107]	Control group design	4 groups: (1) Entering CR (2) Finishing CR[x] (3) Entering CR using personal health assistant (4) Finishing CR using personal health assistant[x]	Personal Health Assistant (PHA)	76 (72 after drop-out)	Clinic patients (1)&(2) M_{age} = 70.4 (*SD* = 9.9); M_{BMI} = 30.6 (*SD* = 5.6) (3)&(4) M_{age} = 60.2 (*SD* = 12.1); M_{BMI} = 29.2 (*SD* = 4.4)	Test a digital health intervention as an adjunct to cardiac rehabilitation (CR).	App + e-mail reminder	3 months (study and intervention)	Blood pressure, weight, blood parameters	*Dietary pattern (study specific score)*	**Body weight** **BMI** **Cholesterol** *systolic blood pressure, diastolic blood pressure, triglyceride, HDL, LDL, glucose*	10

Review										Meta-analysis		
Study description (as reported in the primary article)										**Outcomes included in the analyses**		
Author	**Design**	**Study groups**[1]	**App**[2]	**Sample size**	**Partici-pants**	**Aim of the study**	**Inter-vention**	**Duration**	**Outcomes as reported in the primary study**	**Nutrition behaviours**	**Nutrition-related health outcomes**	**#Outcomes**
Willey & Walsh, 2016 [108]	Quasi-experimental	1 group	YouPlus Health mobile coaching platform	10	Caucasian women M_{age} = 43.5 (range: 35-49); M_{BMI} = 31.6 (range: 27.2-36.4)	Evaluation of participants using the YouPlus Health mobile coaching platform.	App only	3 months (study and intervention)	Weight, waist circumference, blood pressure, lipids, glyco-haemoglobin, maximum volume of oxygen consumption		**Body weight** **Cholesterol** *Waist circumference, systolic blood pressure, diastolic blood pressure, triglyceride, HDL, LDL, glyco-haemoglobin*	9

Supporting Information 9

Funnel plot for the all-encompassing data set with observed effect size Hedges' *g* on the horizontal axis plotted against the standard error



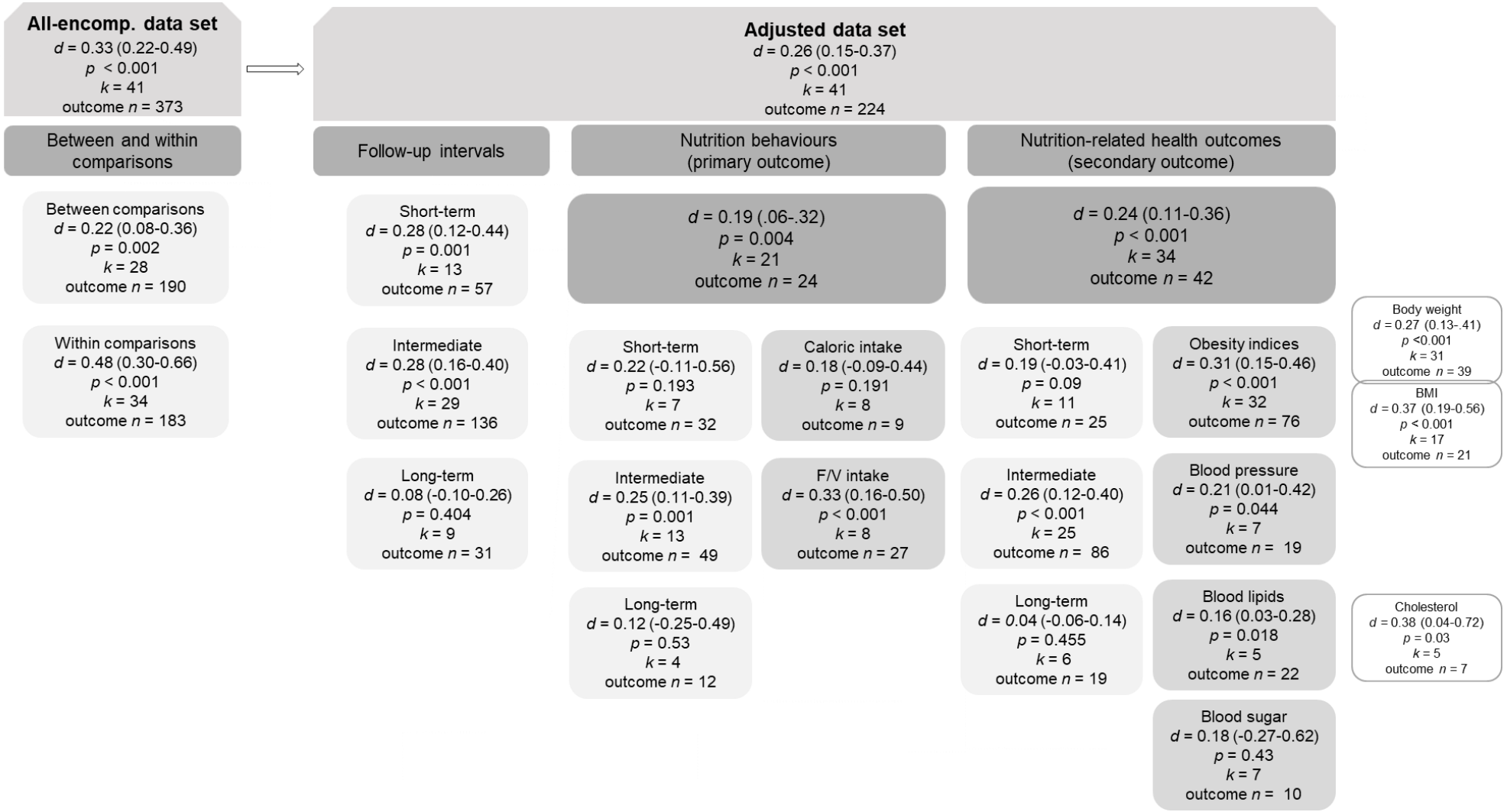
Supporting Information 10

Meta-regression and moderation effect results

Moderator	Estimate	*SE*	*p*	*CI*
Study design (RCT vs. no-RCT)	0.06	0.11	0.622	-0.17 - 0.28
Study quality	-0.18	0.12	0.120	-0.41 - 0.05
Sample size	-0.00	0.00	0.710	-0.00 - 0.00
Sample characteristic (clinical vs. non-clinical)	0.11	0.11	0.287	-0.10 - 0.32
Study sample (adolescents vs. adults)	0.12	0.24	0.602	-0.34 - 0.59
Study duration	-0.00	0.00	0.163	-0.01 - 0.00
Intervention duration	-0.00	0.00	0.304	-0.01 - 0.00
Drop-out rate (%)	-0.00	0.00	0.875	-0.01 - 0.01
Number of included outcomes	-0.01	0.01	0.467	-0.03 - 0.01
Type of app (commercial vs. research)	-0.07	0.10	0.457	-0.26 - 0.12
Treatment component in addition to app (app only vs. app+)	0.06	0.11	0.606	-0.16 - 0.27
Number of BCTs	-0.01	0.02	0.564	-0.06 - 0.03

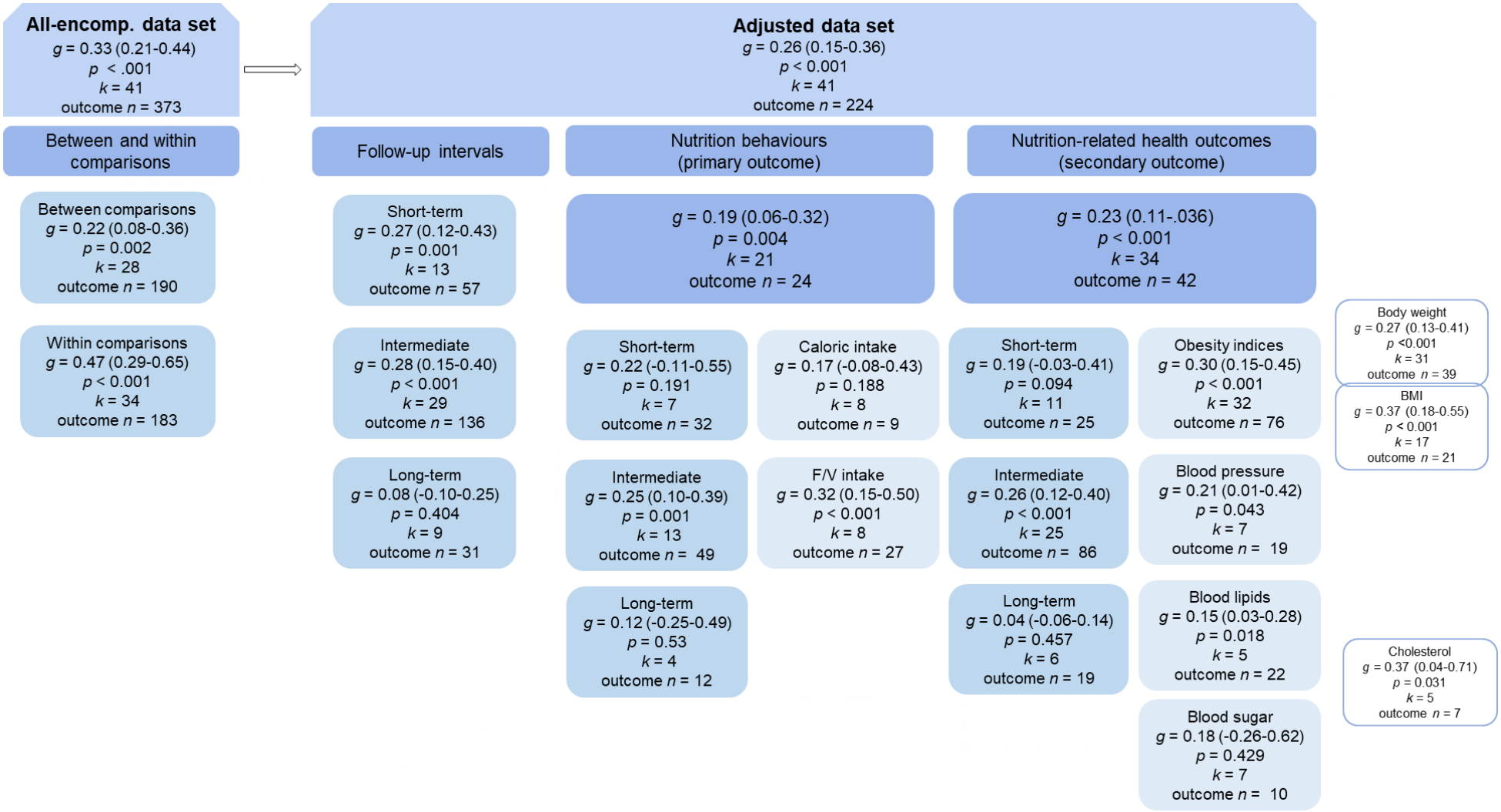
Supporting Information 11

Effect sizes (Cohen's *d*) for all analysis levels and outcomes



Supporting Information 12

Effect sizes (Hedges' *g*) for all analysis levels and outcomes



Supporting Information 13

Forest plots for outcomes

I. Nutrition behaviours

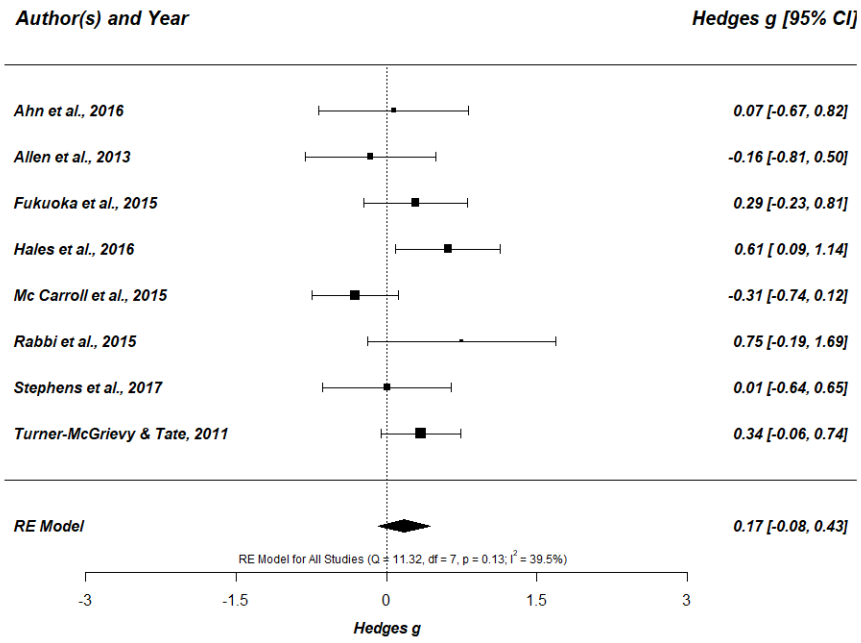


Figure 13.1. Forest plot showing the effects of app-based mobile interventions on caloric intake (k = 8, outcome n = 9; adjusted data set).

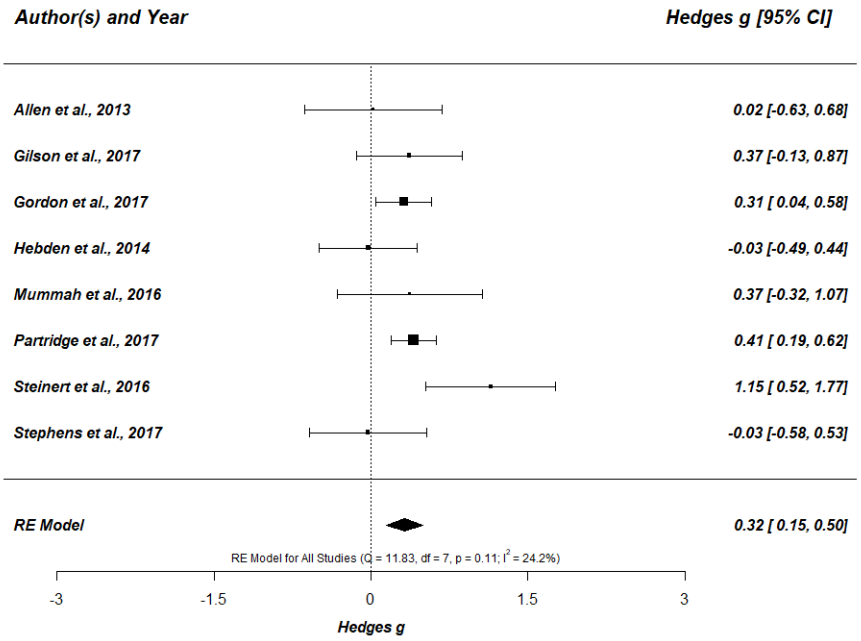


Figure 13.2. Forest plot showing the effects of app-based mobile interventions on fruit/vegetable intake (k = 8, outcome n = 27; adjusted data set).

II. Nutrition-related health outcomes

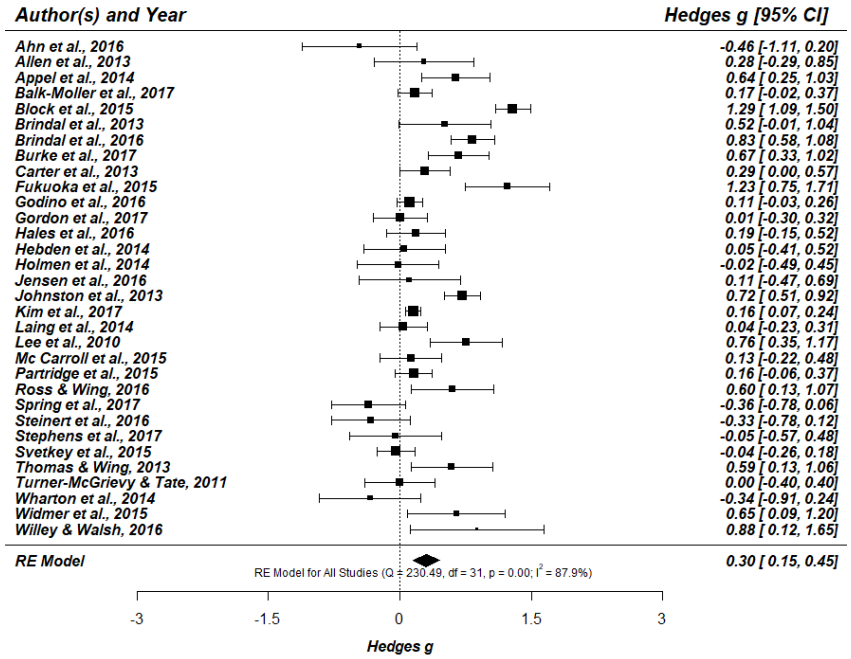


Figure 13.3. Forest plot showing the effects of app-based mobile interventions on obesity indices (k = 32, outcome n = 76; adjusted data set).

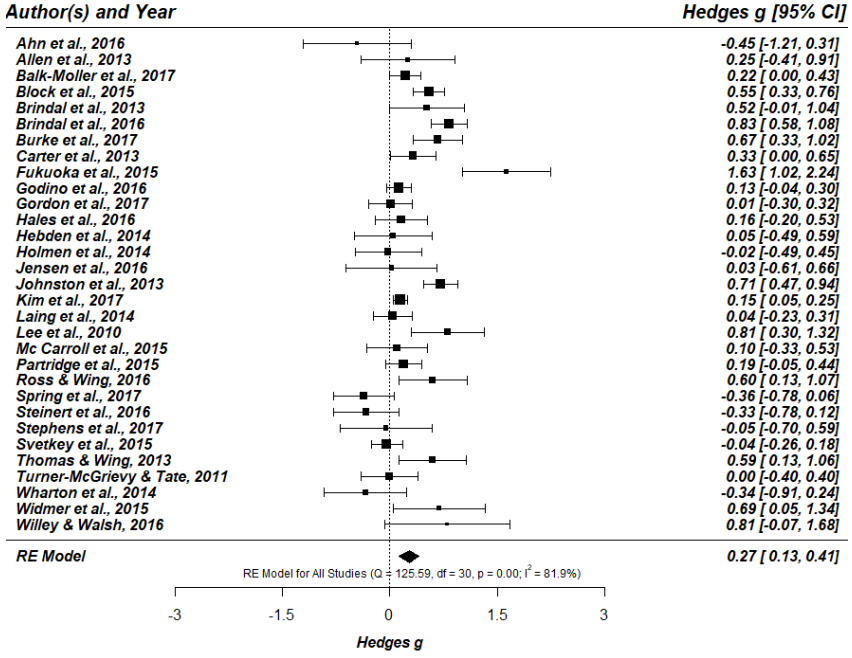


Figure 13.4. Forest plot showing the effects of app-based mobile interventions on body weight (k = 31, outcome n = 39; adjusted data set).

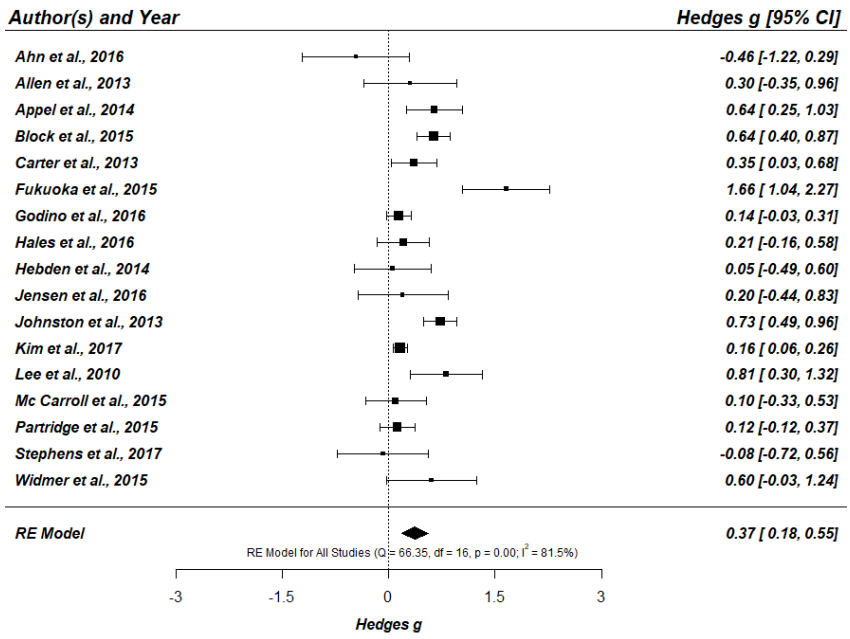


Figure 13.5. Forest plot showing the effects of app-based mobile interventions on BMI (*k* = 17, outcome *n* = 21; adjusted data set).

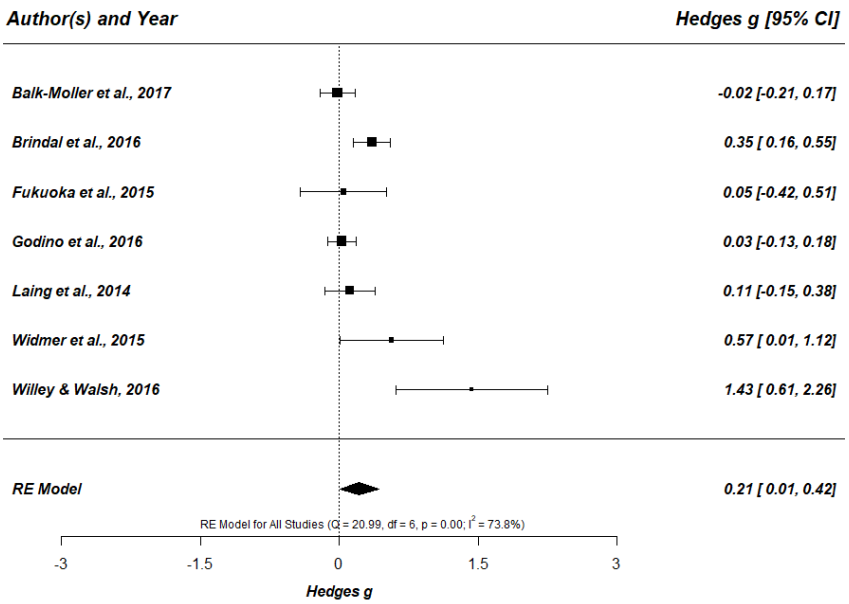


Figure 13.6. Forest plot showing the effects of app-based mobile interventions on blood pressure (k = 7, outcome n = 19; adjusted data set).

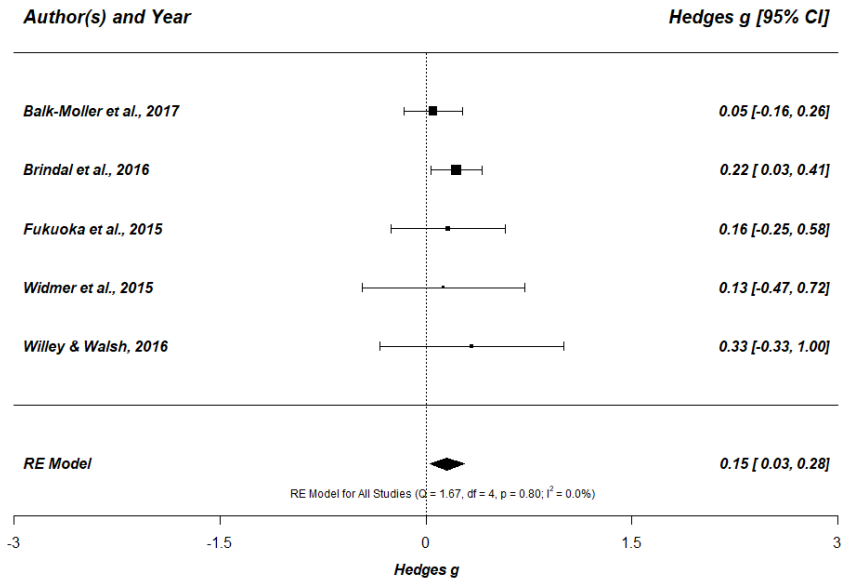


Figure 13.7. Forest plot showing the effects of app-based mobile interventions on blood lipids (k = 5, outcome n = 22; adjusted data set).

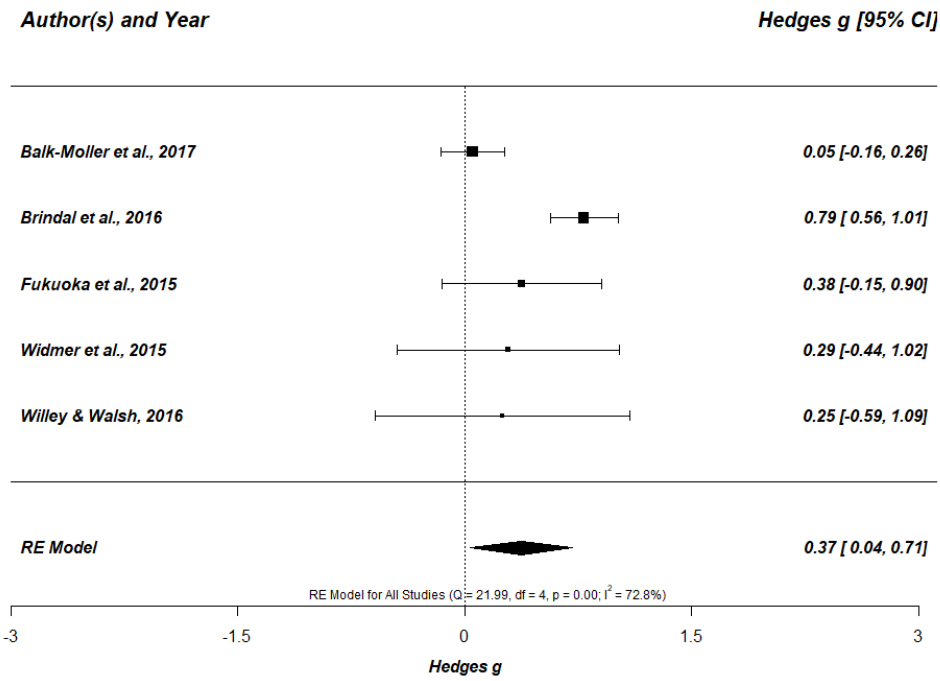


Figure 13.8. Forest plot showing the effects of app-based mobile interventions on cholesterol (k = 5, outcome n = 7; adjusted data set).

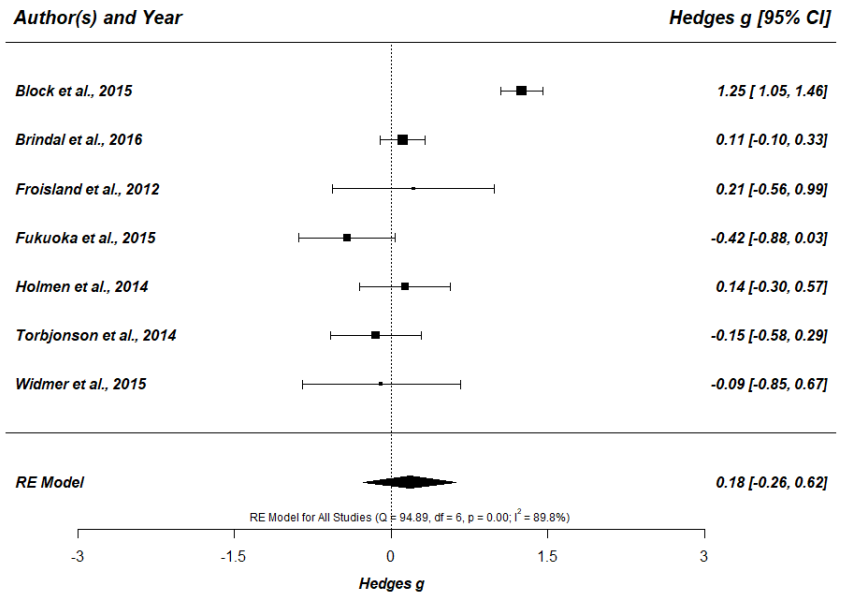


Figure 13.9. Forest plot showing the effects of app-based mobile interventions on blood sugar (k = 7, outcome n = 10; adjusted data set).

Supporting Information 14

Weighted mean differences for BMI and body weight

Table 14.1

Weighted mean differences for BMI (kg/m^2) for the intervention group (k = 13)

	Difference (BMI points)	**Weights**	**Weighted mean difference (BMI points)**
Ahn et al., 2016	0.21	3.50	3.71
Allen et al., 2013	-1.22	4.11	-5.01
Appel et al., 2014	0.08	6.27	0.50
Carter et al., 2013	-1.60	6.89	-11.02
Fukuoka et al., 2015	-2.00	4.39	-8.78
Hales et al., 2016	-1.41	6.47	-9.09
Hebden et al., 2014	-0.58	4.96	-2.88
Kim et al., 2017	-1.05	8.54	-8.97
Lee et al., 2010	-0.80	5.22	-4.18
Mc Carroll et al., 2015	-0.80	5.92	-4.74
Partridge et al., 2015	-0.90	7.55	-6.80
Stephens et al., 2017	-0.63	4.21	-2.63
Widmer et al., 2015	-1.20	4.23	-5.08
Mean	**-0.92**		**-0.90**

Note. Includes intervention studies specifying absolute mean difference in BMI points (kg/m^2) for the intervention group. Out of 17 studies reporting BMI changes (see Supporting Information 13.5), one was excluded due to outlier values (Block et al., 2015) and three did not report within BMI changes (Godino et al., 2016, Jensen et al., 2016 and Johnston et al., 2013), and thus, they were not included.

Table 14.2

Weighted mean differences for body weight in kilograms for the intervention group (k = 29)

	Difference (kg)	**Weights**	**Weighted mean difference (kg)**
Ahn et al., 2016	0.64	1.95	1.25
Allen et al., 2013	-3.56	2.27	-8.08
Balk-Moller et al., 2017	-1.24	4.15	-5.15
Brindal et al., 2016	-5.88	4.02	-23.64
Burke et al., 2017	-2.79	3.59	-10.02
Carter et al., 2013	-4.60	3.70	-17.02
Fukuoka et al., 2015	-5.70	2.42	-13.79
Godino et al., 2016	-0.52	4.32	-2.27
Gordon et al., 2017	-0.20	3.76	-0.77
Hales et al., 2016	-3.75	3.49	-13.09
Hebden et al., 2014	-1.60	2.72	-4.35
Holmen et al., 2014	-1.30	3.03	-3.94
Jensen et al., 2016	0.09	2.35	0.20
Johnston et al., 2013	-4.60	4.07	-18.72
Kim et al., 2017	-2.98	4.50	-13.41
Laing et al., 2014	-0.03	3.93	-0.12
Lee et al., 2010	-1.90	2.84	-5.40
Mc Carroll et al., 2015	-2.30	3.21	-7.38
Partridge et al., 2015	-1.90	4.02	-7.64
Ross & Wing, 2016	-5.22	3.01	-15.71
Spring et al., 2017	-3.97	3.23	-12.81
Steinert et al., 2016	0.50	3.10	1.55
Stephens et al., 2017	-1.80	2.32	-4.18
Svetkey et al., 2015	-1.11	4.15	-4.62
Thomas & Wing, 2013	-9.65	3.03	-29.24
Turner-McGr. & Tate, 2011	-2.50	3.35	-8.38
Wharton et al., 2014	-1.59	2.57	-4.09
Widmer et al., 2015	-4.00	2.32	-9.28
Willey & Walsh, 2016	-6.12	1.63	-9.98
Mean	**-2.74**	**-**	**-2.69**

Note. Includes intervention studies specifying absolute mean difference in body weight in kg (or lbs) for the intervention group. Out of the 31 studies reporting body weight changes (see Supporting Information 13.4), one was using a different metric (Brindal et al., 2013), and one was excluded due to outlier values (Block et al., 2015) and thus, they were not included.