

Effectiveness of App-Based Multimodal Behavioral Interventions on Weight Loss in Obesity: A Systematic Review and Meta-Analysis

Supplementary Materials

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Table S1: Search String PubMed

#	Query
1	"obes*" OR obesity[MeSH Terms]
2	"digital health" OR "mHealth" OR "DTx" OR "Mobile Applications"[Mesh]
3	((("lifestyle" OR "diet" OR "exercise" OR "physical activity" OR "behavior") AND ("therapy" OR "treatment" OR "program*" OR "intervention" OR "coaching")) OR ("Behavior"[Mesh] OR "Exercise"[Mesh] OR "Life Style"[Mesh] OR "Weight Reduction Programs"[Mesh]))
4	("weight reduction" OR "weight loss" OR "quality of life" OR "QOL" OR wellbeing) OR ("Weight Loss"[Mesh] OR "Quality of Life"[Mesh])
5	"Drug Therapy"[Mesh] OR pharmaco* OR surgery OR bariatric OR gastric balloon OR gastric bypass OR animal OR mouse OR rat OR child* OR teen* OR adolesc* OR "juvenile" OR pregna*
6	(#1 AND #2 AND #3 AND #4) NOT #5
Results: 363	

Date of Search: 20.02.2025; Filter: Publication Year 2014-2025

Table S2: Search String IEEE Xplore

#	Search Fields	Operator	Query
1	All Meta Data	AND	obesity
2			"digital health" OR mHealth OR DTx OR "Mobile Applications"
3			lifestyle OR "weight reduction program"
4			"weight reduction" OR "weight loss" OR "quality of life" OR QOL OR wellbeing

Final Search:

("All Metadata":obesity) AND ("All Metadata": "digital health" OR "All Metadata":mHealth OR "All Metadata":DTx OR "All Metadata": "Mobile Applications") AND ("All Metadata":lifestyle OR "All Metadata": "weight reduction program") AND ("All Metadata": "weight reduction" OR "All Metadata": "weight loss" OR "All Metadata": "quality of life" OR "All Metadata":QOL OR "All Metadata":wellbeing)

Results: 8

Date of Search: 20.02.2025; Filter: Publication Year 2014-2025

Table S3: Search String Nature

#	Query
1	obes* AND ("digital health" OR mHealth OR DTx OR "Mobile Applications") AND (((lifestyle OR diet OR exercise OR physical activity OR behavior) AND (therapy OR treatment OR program* OR intervention OR coaching)) OR "weight reduction program*") AND ("weight reduction" OR "weight loss" OR "quality of life" OR QOL OR wellbeing) NOT ("Drug Therapy" OR pharmaco* OR surgery OR bariatric OR gastric balloon OR gastric bypass OR animal OR mouse OR rat* OR child* OR teen* OR adolesc* OR juvenile OR pregna*)
Results: 26	
Date of Search: 21.02.2025; Filter: Publication Year 2014-2025	

Table S4: Search String PubPsych

#	Query
1	obesity AND ("digital health" OR mHealth OR DTx OR "Mobile Applications") AND (lifestyle OR "weight reduction program*") AND ("weight reduction" OR "weight loss" OR "quality of life" OR QOL OR wellbeing) PY>=2014 PY<=2025
Results: 17	
Date of Search: 21.02.2025; Filter: Publication Year 2014-2025	

Table S5: Search String Cochrane

#	Query	Hits
1	obes*	63496
2	MeSH descriptor: [Obesity, Abdominal] explode all trees	581
3	#1 OR #2	63496
4	digital health OR mHealth OR DTx	4978
5	MeSH descriptor: [Mobile Applications] explode all trees	2225
6	#4 OR #5	6719
7	(lifestyle OR diet OR exercise OR "physical activity" OR behavior) AND (therapy OR treatment OR program* OR intervention OR coaching)	261839
8	MeSH descriptor: [Behaviorism] explode all trees	3
9	MeSH descriptor: [Exercise] explode all trees	39252
10	MeSH descriptor: [Life Style] explode all trees	8763
11	MeSH descriptor: [Weight Reduction Programs] explode all trees	1140
12	#7 OR #8 OR #9 OR #10 OR #11	276803
13	weight reduction OR "weight loss" OR "quality of life" OR QOL OR wellbeing	222664
14	MeSH descriptor: [Weight Loss] explode all trees	9025
15	MeSH descriptor: [Quality of Life] explode all trees	43962
16	#13 OR #14 OR #15	222840
17	pharmaco* OR surgery OR bariatric OR "gastric balloon" OR "gastric bypass" OR animal OR mouse OR rat OR child* OR teen* OR adolesc* OR juvenile OR pregna*	906106
18	MeSH descriptor: [Drug Therapy] explode all trees	181919
19	#17 OR #18	982919
20	(#3 AND #6 AND #12 AND #16) NOT #19	152
		Results: 151 Trials
		1 Review

Date of Search: 21.02.2025; Filter: Publication Year 2014-2025

Table S6. PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title Page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Table 1
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Search Strategy and Eligibility Criteria; Tables S1-S5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Tables S1-S5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Study Selection and Data Extraction
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Study Selection and Data Extraction
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Outcomes
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear	Study Selection and Data

Section and Topic	Item #	Checklist item	Location where item is reported
		information.	Extraction
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Risk of Bias & Quality Assessment
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Statistical Analysis
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Statistical Analysis
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Statistical Analysis
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Statistical Analysis; Table 2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Statistical Analysis
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Statistical Analysis
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Statistical Analysis
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Risk of Bias & Quality Assessment
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Risk of Bias & Quality Assessment
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Study Selection; Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Study Selection; Figure 1

Section and Topic	Item #	Checklist item	Location where item is reported
Study characteristics	17	Cite each included study and present its characteristics.	Study Characteristics; Table 2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Risk of Bias and Quality Assessment ; Figure 2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Meta Analysis; Figures 3 and 4
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Meta Analysis; Table 3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Meta Analysis; Figures 3 and 4
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Discussion - Possible Explanations for Heterogeneity of Study Results
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Table 3
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Risk of Bias and Quality Assessment
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Table 3
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion - Key Findings
	23b	Discuss any limitations of the evidence included in the review.	Discussion - Strengths and Limitations

Section and Topic	Item #	Checklist item	Location where item is reported
	23c	Discuss any limitations of the review processes used.	Discussion - Strengths and Limitations
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion - Future Implications
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Risk of Bias & Quality Assessment
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Discussion - Strengths and Limitations
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Acknowledgements
Competing interests	26	Declare any competing interests of review authors.	Title Page; Conflicts of Interest
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. This work is licensed under CC BY 4.0.

Table S7. Intervention Characteristics

Interventions Name of the app (if available)	Performance Meta Analysis	No. of BC Components	Behavioral Change Components						
			Self-Monitoring/Tracking	Education	Goal-Setting (incl. "Tasks", Challenges)	(automated) Reminders (e.g. Push Notifications, Messages)	Personalized Feedback	Social Support	Personal (HCP) Contact
Gemesi et al. (2024) Oviva app	HP	5	☒ Nutrition, PA, body weight	☒ Obesity etiology, weight loss recommendations, relapse management	☒ not specified	☒ Reminder to enter data, motivational notifications	☒ Based on analysis of tracking data	☐	☐
Roth et al. (2023) zanadio app	HP	5	☒ Nutrition, PA, body weight	☒ Nutrition, PA, weight gain and weight loss, personal reflection via questions	☒ not specified	☒ Reminders, motivational messages	☒ Weekly reports	☐	☐
Hartman et al. (2016) My FitnessPal	HP	5	☒ Nutrition (via MyFitnessPal), PA (via Fitbit One clip-on)	☒ Nutrition, PA, short-term weight loss (via phone call and handbook)	☒ (via phone call)	☐	☒ (via phone call)	☐	☒ Phone calls
Hesseldal et al. (2022) LIVA app	HP	6	☒ Nutrition, PA, Life Goals, Sleep, Mood, Smoking, Blood Glucose, Blood Pressure	☒ esp. behaviour topics (via phone/video call)	☒ not specified	☐	☒ (via phone/video call)	☒ Online forum	☒ Asynchronous digital coaching, app remarks can be send directly to the coach
Hurkmans et al. (2018)	HP	4	☒ Steps	☒ Nutrition, PA	☐	☐	☐	☒ Facebook Group (in app link)	☒ not specified
Bughin et al. (2021) TR Telemouv app	LP	4	☒ Nutrition (via questionnaires), PA (via pedometer (Care Trackfit), heart rate monitor (Polar H7))	☒ Nutrition, PA, illness	☒ Individualized goals for steps; Tasks with explicit instructions for type and amount of PA	☐	☐	☐	☒ 2 Teleconsultations at 1 and 2 months
Apiñaniz et al. (2019) AKTIDIET® app	LP	3	☒ Nutrition	☒ Nutrition, PA	☐	☒ Text messages	☐	☐	☐
Lugones-Sanchez et al. (2022) EVIDENT 3 app	LP	3	☒ Nutrition (via app), PA (via smart band (Xiaomi Mi Band 2))	☐	☒ No individual goal setting, goals were defined dependant on entered data based on guidelines	☐	☒ Personalized nutrition recommendations	☐	☐
Ruiz-Leon et al. (2025) Greenhabit app	LP	7	☒ Steps, body weight, glucose levels, HbA1c	☒ Nutrition, PA, relaxation, positive thinking, social enviroment (via daily challenges in app), nutrition (via phone call)	☒ not specified	☒ Daily "treasure chest" (containing advice, encouraging phrases, challenges, and self-monitoring)	☒ App content based on initial questionnaire, personalized nutrition advice (via phone call)	☒ Optional 2nd app access for a partner/friend + log-in to patients account to follow journey (just "observer status")	☒ Regular phone calls with dietitian
Simpson et al. (2020) HelpMeDoIt! app	LP	5	☒ Body weight	☒ Nutrition, PA, goal setting, self-monitoring (via website)	☒ (only weight loss goals)	☒ Push and email notifications	☐	☒ Possibility to nominate helpers - helper receive a helper version of the app	☐

Intervention information was extracted from the respective study protocols for Lugones-Sanchez et. al, 2022 (Recio-Rodriguez et al. 2018. DOI: 10.1097/MD.00000000000009633) and Simpson et. al, 2020 (Matthews et al. 2017. DOI: 10.1136/bmjopen-2017-017159); HP, High performer; LP, Low performer; BC, Behavioral change; HCP, Healthcare professional; PA, Physical activity

Table S8. Egger's Regression Test

	Intercept	95 % CI	t	p
SMD	-1.721	-4.96 to 1.52	-1.041	0.328
MD	-1.805	-4.55 to 0.94	-1.288	0.239

MD, Mean difference; SMD, Standardized mean difference.

Table S9. Summary table sensitivity analysis.

	SMD	95% CI	t	p	I²
Main Analysis (k = 10)	-0.4957	[-0.7714; -0.2199]	-4.07	0.0028	79.2%
Sensitivity Analysis - excluding high RoB studies (k = 7)	-0.4231	[-0.7849; -0.0614]	-2.86	0.0287	79.7%
Sensitivity Analysis - 6 months data only (k = 4)	-0.5786	[-1.2347; -0.0812]	-2.79	0.0684	77.9%

CI, Confidence interval; RoB, Risk of bias; SMD, Standardized mean difference.

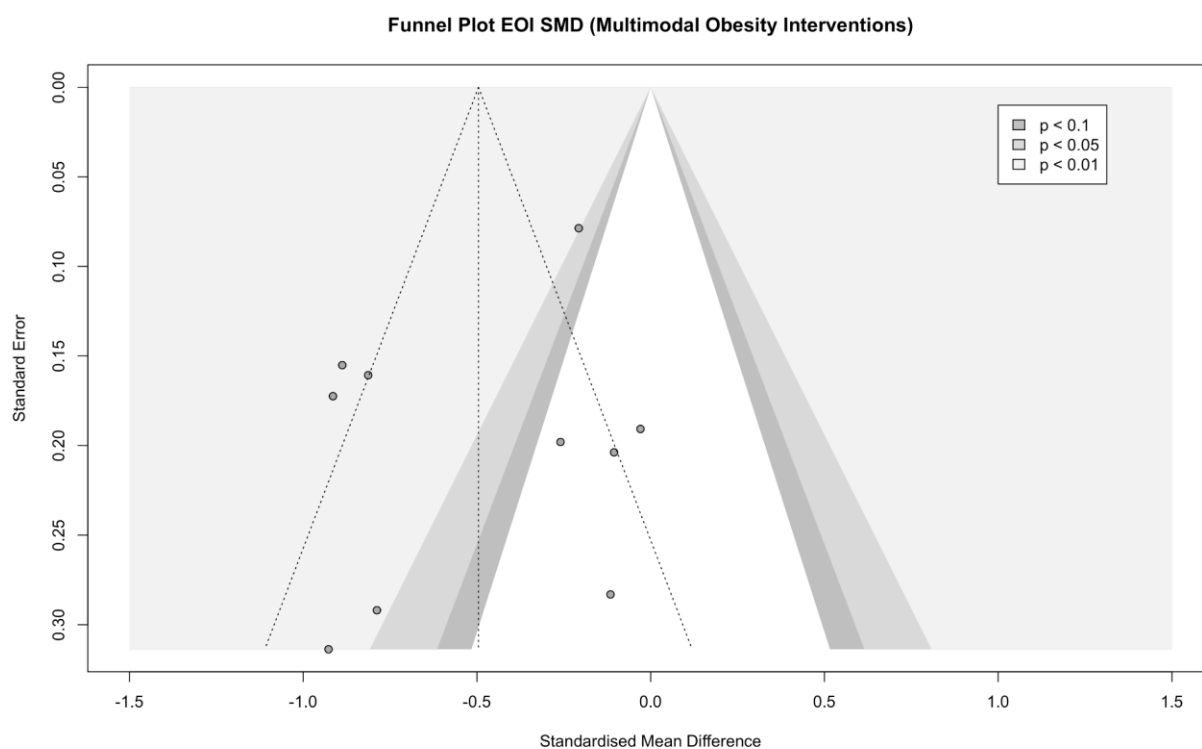


Figure S1. Funnel plot indicating publication bias for the primary endpoint, weight loss at the end of the intervention (SMD). SMD, Standardized mean difference.

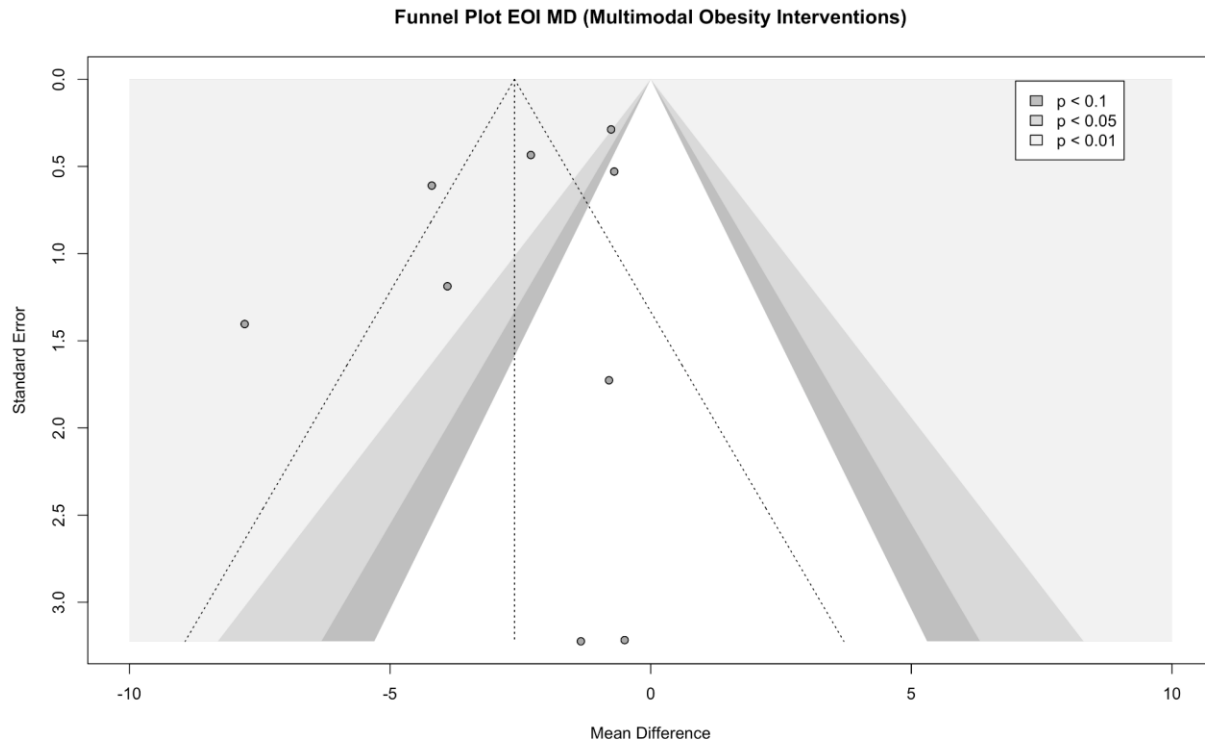


Figure S2. Funnel plot indicating publication bias for the primary endpoint, weight loss at the end of the intervention (MD). MD, Mean difference (kg).

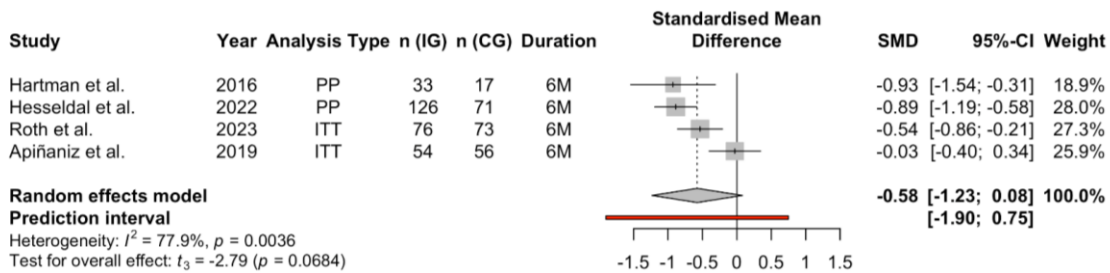


Figure S3. Forest plot meta-analysis SMD at 6 months timepoint. CG, Control group; CI, Confidence interval; IG, Intervention group; SMD, Standardized mean difference.

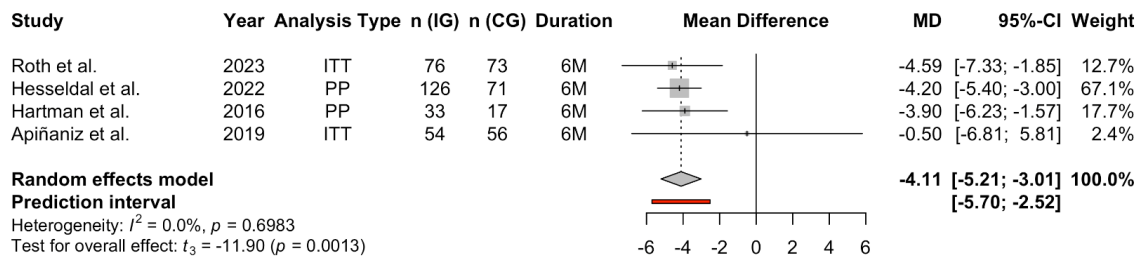


Figure S4. Forest plot meta-analysis MD (kg) at 6 months timepoint. CG, Control group; CI, Confidence interval; IG, Intervention group; MD, Mean difference.