Current mHealth Technologies for Physical Activity Assessment and Promotion

Gillian A. O'Reilly, BS, Donna Spruijt-Metz, PhD

Appendix A

Characteristics of all included articles

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
Anderson (2007)[1]	9	Age, years, M±SD: Mean age not reported; range: 19–54 Female: 55.6% Ethnicity: not reported Mean BMI±SD: not reported Country: not reported	Design: quasi-experimental, short-term study of app prototype Purpose: assess Shakra mobile phone app usability and user response and attitudes toward the app among adults Length: 5 days	Shakra mobile phone app uses Artificial Neural Network to estimate participant's activity level; app uses social networking by sharing participants' activity information with other participants in order to promote sharing and comparison of PA data among peers and motivate individuals to be active; animated representation of user's current PA mode runs continuously on main screen of app to provide real-time feedback	Objective: activity sensing by the Shakra app Subjective: self-reported PA diary	Not reported	Participants' experience with the PA tracking and PA data-sharing features of the Shakra app; impact of PA awareness gained by app on motivation to be active	1. The Shakra app was found to be reliable and stable 2. All participants reported the app was easy to use 3. Participants reported the app provided them with an increased awareness of their activity levels	Weak
Bexelius (2010)[2]	22	Age, years, M±SD: 35.1±8.3 Female: 100% Ethnicity: not reported Mean BMI±SD: 23.7 ± 3.8 Country: Sweden	Design: quasi-experimental Purpose: determine feasibility of using Java-based app for repeated PA measurements	Java-based mobile phone app with two PA questions answered through the app daily; text messages sent to remind about answering PA questions	Objective: Total EE measured by doubly labeled water Subjective: Java-based	Not reported	Agreement between EE estimates from Java-based app and doubly labeled water and indirect calorimetry; feasibility of Java-based app for PA	1. Mean difference between estimated PA levels from Java-based mobile questionnaire and doubly labeled water was small (0.014) and had	Strong

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
			Length: 14 days		question-naires and daily paper-based question-naires		data collection	narrow limits of agreement (2SD = 0.30); 2. Findings support feasibility	
Buttussi (2010)[3]	28	Age, years, M±SD: 1st group: 27.71; 2nd group: 22.29 Female: 42.86% Ethnicity: not reported Mean BMI±SD: not reported Country: not reported	Design: evaluation study Purpose: evaluate mobile phone app usability and understandability using two evaluation groups Length: one (35–50 minute) evaluation session	Mobile app Monsters & Gold uses context-aware, user-adaptive game, combines user heart rate, age, fitness, and exercise phase to motivate user to jog and trains user to exercise at optimal intensity for cardiovascular benefits; mobile phone screen displays virtual trail that advances as the user jogs in real-time; virtual monsters, gold, potions, and shields appear and disappear based on user's jogging speed and heart rate; goal of game is to score "gold points" without losing "health points"; points are gained or lost depending on speeding up jogging pace to reach positive targets (gold, potions, shields) or slowing down to avoid negative obstacles (monsters) along the trails;	Objective: user's position and jogging pace measured by internal phone GPS and physical exertion measured using Bluetooth-enabled pulse oximeter clipped to user's ear Subjective: not applicable	Not reported	Understandability of the game; usefulness of audio and graphics; influence of the game on motivation to jog	1. First evaluation group: most users reported they would jog more often and more willingly if they could always use the Monsters & Gold mobile phone game (mean score on a 5-point Likert scale = 3.64 SD=0.63; 1= *strongly disagree* and 5=*strongly agree*) 2. Second evaluation group: half of the users reported they would jog more often and more willingly if they could always use the Monsters & Gold game (mean score = 3.5, SD=0.94)	Weak
Consolvo (2006)[4]	13	Age, years, M±SD: Mean age not	Design: quasi-experimental pilot	Mobile phone app called Houston with	Objective: pedometer-	Not reported	Percentage of days step count goals	1. Sharing version group more likely to	Moderate

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
		reported; range: 28–42 Female: 100% Ethnicity: not reported Mean BMI±SD: 22.2 (SD not reported) Country: not reported	study Purpose: determine features of app that were important, not important, and what was missing; collect information for future work Length: 3 weeks	journal that displays daily step count, goals, and progress toward goals; app can be used to manually enter step counts, add comments, receive rewards, share messages and step count data with others; encouraged social support: sharing version enabled users to share step counts, goal progress, and messages with peers (all optional); designed to encourage users to increase daily step count	recorded step count Subjective: self-reported step count and other PA recorded in Houston app		were met for sharing versus personal groups	meet daily step count goals than personal version group ($p<0.05$) 2. Average daily step counts increased for seven participants from baseline (median 30%; nonsignificant group difference)	
Consolvo (2008)[5]	12	Age, years, M±SD: Mean age not reported; range: 25–35 Female: 50% Ethnicity: not reported Mean BMI±SD: not reported Country: U.S.	Design: quasi-experimental field trial Purpose: Determine UbiFit usability and acceptability; test activity inference vs manual PA journaling Length: 3 weeks	Mobile sensing platform; interactive application; can glance at display to see aesthetic representation of PA goal attainment; app displays a virtual garden that motivates PA by accumulating different flowers and butterflies in response to PA	Objective: On-body sensors and real-time activity inference Subjective: app journal feature to allow manual corrections of PA inferences	Not reported	Types of activities UbiFit supports; participant interaction with UbiFit system; participant reaction to activity inference and manual journaling	1. The UbiFit app supports measurement of a variety of activities 2. 61% of activities performed were manually journaled by participants, 39% were inferred by UbiFit; 77% of inferred activities were unchanged by participants 3. Participants reported journal feature was quick and simple to use but wanted the app to automatically log activities	Moderate

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David (2012)[6]	71	Age, years, M±SD: 57±5 Female: 100% Ethnicity: white: 93%; other: 7% Mean BMI±SD: 31.5±4.1 Country: U.S.	Design: RCT with two arms: walking intervention with personal coach, walking intervention without personal coach Purpose: determine the feasibility of using mobile phones and an IVR system for self-monitoring of walking in postmenopausal women Length: 12 weeks	Use of mobile phones to administer walking intervention using an IVR system and for participants to report daily step counts; participants had two daily interactions with the IVR system, IVR system called participants once/day and asked three questions: whether participant had walked that day or planned to walk that day, participant's self-efficacy to achieve step count goal that day, whether participant was having a good or bad day, IVR system also delivered a message focused on a theme that was the focus for the intervention that week (e.g., self-monitoring, awareness of barriers); participant called IVR system in the evening to report daily step count from pedometer, provide assessment of self-efficacy for walking the following day, and assessment of satisfaction with their walking from that day	Objective: not applicable Subjective: self-reported daily step count measured by pedometer	Goal-setting Theory, Social Cognitive Theory, Problem-solving Theory, Trans-theoretical Model	Change in time taken to complete a 1-mile walk between baseline and post-intervention; anthropometrics; psychometrics; influence of a health coach on walking behavior	1. Significant decrease in time to complete a 1-mile walk (post–pre intervention time = –0.77 minutes, p=0.001) 2. Medium-size effect for improvement in time taken to complete the 1-mile walk (Cohen's d= 0.40)	Moderate
Dunton (2011)[7]	121	Age, years, M±SD: 11±1.8	Design: quasi-experimental	Electronic EMA using mobile phones	Objective: PA	Not reported	Step count and MVPA minutes within	1. No significant differences between	Strong

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
		Female: 49% Ethnicity: African-American: 10%; Asian: 12.5%; Hispanic/Latino: 32.5%; white: 23.3%; mixed race: 15.8%; other: 5.8% Mean BMI±SD: Not reported Country: U.S.	Purpose: examine the feasibility, acceptability, and validity of electronic EMA to measure PA and sedentary behaviors in children Length: 4 days	captured PA and sedentary behavior in real time; use of custom version of MyExperience software on mobile phones to deliver EMA surveys; electronic surveys presented questions about current activity on display of mobile phone three to seven times/day; participants prompted to complete surveys with audio prompts from mobile phones	measured using accelero-meter Subjective: current activity reported by participants using electronic EMA surveys, self-reported PA time-matched to accelero-meter data		30 minutes prior to each EMA prompt; Analysis of whether participants were willing to answer EMA prompts during exercise; analysis of whether EMA prompt nonresponse was related to current PA levels; comparison of self-reported activity and accelerometer data to determine if participants answered EMA prompts about PA honestly/accurately	answered and unanswered prompts for step counts or MVPA 2. Step counts and likelihood of 5 or more minutes of MVPA were significantly higher during activity vs sedentary behavior reported by EMA (p<0.001) 3. EMA prompts feasible and acceptable to collect PA data from children as young as 9 years	
Emken (2012)[8]	20	Age, years, M±SD: 14.6±1.8 Female: 50% Ethnicity: Hispanic/Latino: 100% Mean BMI±SD: 31.6±6.3; BMI percentile: 95.8±3.7 Country: U.S.	Design: quasi-experimental laboratory assessment Purpose: evaluate the accuracy of the KNOWME Networks PA detection system in a laboratory setting using personalized and generalized PA detection models Length: four sessions, 1–1.5 hours each	KNOWME Networks PA detection system, a mobile, wearable body area network, used wireless, Bluetooth-enabled on-body sensors (heart rate monitor and accelerometers) to detect PA states; data from the on-body sensors were communicated to a secure server in real time using the mobile phone app; mobile phone app display showed participant's number of sedentary minutes	Objective: real-time PA detection using the KNOWME Networks suite of sensors and mobile phone app Subjective: not applicable	Not reported	Accuracy of PA state detection/classify-cation using personalized and generalized PA models	1. The KNOWME system had an overall 84% accuracy of PA state detection 2. The system had some difficulties distinguishing between static and fidgeting sedentary behaviors, but when these behaviors were collapsed, accuracy increased to 94% 3. Personalized models were more accurate than generalized models	Moderate

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
Fjeldsoe (2010)[9]	88	Age, years, M±SD: 30±6 Female: 100% Ethnicity: not reported Mean BMI±SD: 27±6 Country: Australia	Design: RCT with one intervention and one control group Purpose: assess the efficacy and feasibility of an SMS-based intervention for increasing frequency and duration of PA of postnatal women Length: 12 weeks	Personally tailored SMS sent three to five times/week; SMS promoted cognitive and behavioral strategies for PA, focused on self-efficacy, goal-setting skills, outcome expectancy, social support, and perceived environmental opportunity for PA; participant-nominated support person received two SMS/week regarding providing support for the participant	Objective: not applicable Subjective: self-reported frequency and duration of sitting, light-intensity, brisk walking, moderate-intensity, and vigorous-intensity PA using the Australian Women's Activity Survey (AWAS)	Social Cognitive Theory	PA frequency (days/week) and duration (minutes/week); number of days per week participant reported at least 30 minutes MVPA or walking (frequency) and total duration (minutes/week) of MVPA and walking	1. Intervention participants increased PA frequency by 1.82 days/week by 13 weeks (p=0.038), and walking for exercise frequency by 1.08 days/week by 13 weeks (p=0.02) 2. Between-group difference in change in MVPA frequency significant between baseline and 6 weeks (p=0.003), and between baseline and 13 weeks (p=0.0001)	Moderate
Fujiki (2008)[10]	10	Age, years, M±SD: 37.9±7.5 Female: 80% Ethnicity: not reported Mean BMI±SD: 30.5±6.4 Country: U.S.	Design: pilot study Purpose: use persuasive gaming app called Neat-o-Games to encourage non-exercise activity thermogenesis and activity in the daily routine; assess usability and impact on activity of Neat-o-Games app in free-living context Length: 4 weeks	Mobile phone app Neat-o-Games, consisting of a racing game (Neat-o-Race) and a Sudoku game (Neat-o-Sudoku), runs on the background of the mobile phone; wireless on-body sensors communicate body movements to the mobile phone app, advancing an avatar (caricature of a celebrity) through the Neat-o-Race in real time; users compete	Objective: movement measured using on-body accelero-meter that communi-cated activity data to the mobile phone app Subjective: not applicable	Not reported	Participants' physical and behavioral modification; app usability	1. Many participants sustained elevated activity level throughout the 4-week study (significance not reported) 2. All participants completed the usability tasks in the required time; results from the usability tests indicated the app was adequately designed	Weak

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				with other users for points gained through physical activity used to advance through the Neat-o-Race game; points can be used for hints to complete the Neat-o-Sudoku game					
Fukuoka (2011)[11]	41	Age, years, M±SD: 48.4±3.1 Female: 100% Ethnicity: 58.5% nonwhite Mean BMI±SD: BMI >30: 58.5% Country: U.S.	Design: quasi-experimental Purpose: encourage increase of PA in sedentary women; determine compliance with the system and concordance between step count measurement from pedometer and self-reported step count through the mobile phone diary Length: 3 weeks	Mobile phone app called mPED for PA composed of two parts: daily text message prompts and PA diary used to record and self-monitor daily steps, and duration, intensity, and frequency of PA	Objective: step counts from pedometer Subjective: self-reported step count and duration, intensity, and frequency of PA	Not reported	Self-reported step count and PA; agreement between objectively measured step count and self-reported step count	1. Overall self-reported steps increased across 3 weeks (p<0.001) 2. There was high agreement between self-reported and objectively measured step count	Moderate
Hurling (2007)[12]	77	Age, years, M±SD: 40.4±7.6 Female: 66.2% Ethnicity: 98.7% white Mean BMI±SD: 26.3±3.4 Country: United Kingdom	Design: RCT, with one intervention group, one control group Purpose: evaluate the impact of automated Internet + mobile phone–based program, with feedback via Internet, on PA Length: 9 weeks	Automated text message reminders of scheduled weekly exercise plans; automated texts to provide solutions to perceived PA barriers; optional text message reminders about personalized motivating benefits of PA	Objective: Bluetooth-enabled, wrist-worn, uniaxial accelero-meter (Bluetooth Actiwatch) Subjective: self-reported leisure-time PA during	Social psychological theories on automatic goal activation	Change in self-reported and accelerometer-recorded moderate activity; perceived self-control; motivation to exercise	1. Significant increase over baseline in accelerometer-recorded PA in intervention group compared to control; average increase (over control group) in accelerometer-measured PA was 2 hours, 18 minutes/week	Strong

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					previous week using IPAQ			(*p*=0.02) 2. Significant increase over baseline in self-reported leisure-time PA in intervention group compared to control Group 1 (*p*=0.03)	
Kirwan (2012)[13]	200	Age, years, M±SD: Intervention group: 39.3±12.8, Matched control group: 40.1±12.1 Female: 48% Ethnicity: not reported Mean BMI±SD: not reported Country: Australia	Design: two-arm, matched case–control Purpose: to determine if a newly developed smartphone app would improve the self-monitoring and self-reporting of PA of members of an existing online PA behavior intervention called 10,000 Steps; measure user-reported usefulness and usability of app Length: 3 months	iStepLog mobile app developed for Apple platform; intervention participants (*n*=50) given option to report daily step count, daily minutes of moderate activity, and daily minutes of vigorous activity in iStep app, or continue to record PA on the 10,000 Steps program online Step Log; tracking software integrated into the app allowed researchers to monitor how much time participants spent using app, how often they used app to log PA, and features of the app that were most popular	Objective: N/A Subjective: self-reported daily steps from pedometer, minutes of moderate activity, minutes of vigorous activity using mobile app or online log (inter-vention group) or online log only (matched controls)	Not reported	User-reported usability and usefulness of iStep app; total number of steps logged during intervention; total number of days steps were logged during intervention; total number of days steps were logged using iStep app compared to online Step Log; time intervention participants spent using iStepLog	1. Participants reported high mean overall scores for usefulness and usability 2. Use of the app was associated with increased likelihood to log >10,000 steps per entry (OR=20.64 (95% CI: 9.19, 46.39)) 3. Mean number of daily steps logged by intervention group=11,140.22 (±4121.33), which was significantly greater than the mean number of daily steps logged by the control group = 6274.73 (±2106.11; *p*<0.001)	Moderate
Lee (2010)[14]	36	Age, years, M±SD: intervention: 28.2; control: 29.5 (SDs not reported)	Design: case–control study Purpose: assess effectiveness of SmartDiet app to	SmartDiet Mobile phone app collected and analyzed daily dietary intake and PA levels, app calculated	Objective: stop-watch function of app recorded	Not reported	Body composition; user satisfaction	1. Fat mass, weight, and BMI decreased significantly in intervention vs control group	Weak

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
		Female: % not reported Ethnicity: not reported Mean BMI±SD: intervention: 22.2; control: 22.3 (SDs not reported) Country: Korea	collect/store dietary data, assist weight control; assess user satisfaction with SmartDiet app Length: 6 weeks	calorie requirements for exercise; two components: Diet Planner to record dietary intake and PA, Diet Game learning tool for dietary intake and PA; avatar on app screen was thin, normal weight, or overweight based on personal dietary and PA data	PA duration (to calculate calories consumed) Subjective: self-reported PA data could be entered by participant into SmartDiet app			(p<0.05) 2. 58% of participants reported that the SmartDiet app was useful for obtaining diet-related information; 58% of participants reported that the app was easy to use; 50% of participants reported that the app was useful for managing diet	
Mattila (2008)[15]	27	Age, years, M±SD: 39.4±8.1 Female: 31% Ethnicity: Not reported Mean BMI±SD: 28.8±2.4 Country: Finland	Design: quasi-experimental Purpose: usability, usage, and acceptance of the Wellness Diary mobile wellness management app for weight management Length: 3 months	Wellness Diary mobile phone app enables self-observation and reporting of health-related behaviors to support user's health behavior–related decision-making; developed for the Symbian Series 60 mobile phone; functions in conjunction with the calendar app on the phone; user puts self-observations and relevant details into the app; App provides objective feedback in the form of graphs and summaries based on the data reported by the user	Objective: step count uploaded to the Wellness Diary app using an infrared-enabled pedometer Subjective: self-reported PA duration, sport, intensity, distance, and heart rate	Cognitive Behavioral Theory	Number of daily self-observation entries into app, acceptability, usability	1. The Wellness Diary motivated participants to be more physically active; 66% of participants who did not lose weight were motivated to be more physically active, and 71% of participants who did lose weight were motivated to be more physically active (significance not reported) 2. 76% of participants reported that the app was easy to learn; 88% of participants reported that the app was easy to use	Moderate

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
Napolitano (2012)[16]	52	Age, years, M±SD: 20.47±2.19 Female: 86.5% Ethnicity: white: 57.7%; African-American: 30.8%; Hispanic: 5.8%; other: 5.7% Mean BMI±SD: 31.36±5.3 Country: U.S.	Design: RCT with three arms: Facebook only; Facebook plus text messaging and personalized feedback; and waitlist control Purpose: determine the feasibility, acceptability, and efficacy of a weight loss intervention for college students using technology-based intervention implementation Length: 8 weeks	Participants in the Facebook plus text messaging and personalized feedback arm only: received three texts/week that requested participants to send self-monitored weight, caloric intake, and PA data, and received immediate personalized feedback based on the data they reported; received two texts/week about general self-monitoring of diet and PA; received two texts/week that contained tips about self-identified high-risk diet and activity behaviors	Objective: not applicable Subjective: self-reported PA by participants in Facebook plus text-messaging arm; modified Godin Leisure-Time Exercise Question-naire for strenuous, moderate, mild PA in past 7 days	Not reported	Primary: weight loss Secondary: PA behavior, goal-setting, and planning, PA self-efficacy, weight self-efficacy, adapted social support for diet and exercise, engagement/compliance, satisfaction with program	No difference in PA behavior within or between study arms	Strong
Prestwich (2010)[17]	149	Age, years, M±SD: 23.4±5.6 Female: 63.8% Ethnicity: not reported Mean BMI±SD: not reported Country: United Kingdom	Design: RCT, two intervention arms and one control arm Purpose: determine if a PA intervention using text messages with implementation intention content increased brisk walking Length: 4 weeks	Implementation intentions paired with SMS used to send brisk walking plan reminders or brisk walking goal reminders to the intervention arms	Objective: not applicable Subjective: self-reported walking measured using a subset of the Self-Report Walking and Exercise Tables (SWET) measure	Gollwitzer's Implemen-tation Intentions	Self-reported PA; measures of implementation intention and goal recall; weight; waist-to-hip ratio	1. Implementation intention + plan reminder vs control and implementation intention + goal reminder vs control conditions increased the number of days they met the PA daily guidelines, through brisk and fast walking, significantly more than the control group (p=0.04, p=0.03) 2. Number of days/week brisk	Strong

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								walking ≥30 minutes, and number of days exercised including walking in goal reminder and plan reminder groups increased from baseline to follow-up (p<0.001)	
Shapiro (2008)[18]	58	Age, years, M±SD: 8.7±2.3 Female: parents: 91%; children: 62% Ethnicity: white: 60%; African-American: 34%; Asian: 2%; Hispanic/Latino: 2% Mean BMI±SD: BMI: 27.0±6.5; BMI percentile: 94.8±12.1 Country: not reported	Design: RCT; two intervention arms: SMS-based self-monitoring and paper diary–based self-monitoring; no monitoring control arm Purpose: assess the acceptability and efficacy of using SMS messaging to monitor screen time, sugar sweetened beverages, and PA in children Length: 8 weeks	Use of SMS to communicate self-monitoring of health behaviors with targeted feedback; SMS-based self-monitoring arm instructed to send two SMS/day re: behavior goals; immediate automated SMS returned with content based on how many behavior goals met by parents and children	Objective: not applicable Subjective: pedometer to measure step count for parent–child dyads in the two intervention arms; self-report of parent and child step count from pedometer	Cognitive Social Learning Theory	Achievement of behavior changes for parents and children: goal of at least 5000 steps/day, reduction of sugar sweetened beverages to zero/day, reduction in daily screen time	No difference in daily step count between any arms	Weak
Sirriyeh (2010)[19]	120	Age, years, M±SD: 17.3±0.68 Female: 70% Ethnicity: not reported Mean BMI±SD: not reported Country: United Kingdom	Design: RCT; three intervention arms and control arm Purpose: assess the feasibility and efficacy of affective SMS targeting instrumental beliefs, affective beliefs, or both to increase PA in	Daily SMS messages with content aimed at manipulating instrumental beliefs, affective beliefs, or both instrumental and affective beliefs (intervention arms) relating to PA, or neutral SMS message (control)	Objective: not applicable Subjective: self-reported 7-day PA recall using IPAQ	Theory of Planned Behavior	Self-reported PA behavior change	1. Significant interaction between intervention arm and current self-reported PA level (p=0.006) 2. Inactive participants in affective beliefs message arm increased PA significantly more	Moderate

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			adolescents Length: 2 weeks					than the instrumental (p=0.012); combined (p=0.002); and control groups (p=0.018)	
Spring (2012)[20]	204	Age, years, M±SD: 32.8±11.0 Female: 76.5% Ethnicity: white: 53.4%; African-American: 23.0%; Hispanic/Latino: 8.5%; Asian: 11.3%; other: 3.5% Mean BMI±SD: 28.3±7.3 Country: not reported	Design: RCT with four intervention groups Purpose: assess optimal combination of diet and PA intervention from four treatments for maintenance of diet and PA behavior change Length: 3 weeks	"Remote coaching" with assistance of mobile decision support technology; use of PDA for self-monitoring of daily dietary intake, MVPA, and sedentary leisure time; communication of time-stamped behavioral data to lifestyle coaches	Objective: accelero-metry Subjective: daily self-report minutes of sedentary and physical activity	Behavioral Choice Theory	Overall change in diet (increased fruit/vegetable and decreased saturated fat) and activity (decreased sedentary time and increased physical activity) behaviors using a composite diet–activity improvement score	1. The treatment group that increased fruits and vegetables and decreased sedentary leisure time had greater improvement than the other treatment groups starting after 1 week of the intervention and continuing throughout the follow-up phase, p<0.001 2. Sedentary leisure time in this group decreased from 219.2 (±93.8) minutes at baseline to 89.3 (±65.5) minutes at end of treatment to 125.7 (±108.7) minutes at the end of the 20-week follow-up	Strong
Sternfeld (2012)[21]	48; 623	Age, years, M±SD: pilot: 55.6±5.8; validation: 56.9±5.7 Female: pilot: 52%; validation: 52.5%	Design: pilot study and subsequent validation study Purpose: compare a mobile phone–based PA diary with traditional	Mobile phone–based PA diary, with database of 136 activities and associated MET tasks organized into 15 domains (e.g., work-	Objective: no objective PA measure-ment in pilot study; accelero-	Not reported	Estimated PA, data quality, and user preference of mobile phone–based diary vs paper-based diary; test–retest repeatability of	1. PA estimates from mobile phone diary and paper diary were similar (p=0.49 for total PA, p=0.53 for MVPA)	Weak

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
		Ethnicity: (pilot) white: 58.3%; African-American: 29.2%; other: 10.4%; (validation) white: 60.6%; African-American: 19.3%; other: 20.7% Mean BMI±SD: Pilot: not reported; validation: men=28.1±5.4, women=30.4±5.9 Country: U.S.	paper-based PA diary and determine the reliability and validity of the mobile phone–based diary Length: pilot: 3 weeks; validation: two periods of 7 days, 6 months apart	related activities, sports, household activities); questions about each activity domain begin with asking if the user has done any activities in the activity domain since the time of the last diary entry; a response of "yes" by the user prompts a list of specific activities in the activity domain; user reports duration and intensity of activity for each activity selected; participants reported activities three times/day and transmitted data wirelessly; if transmission was missed, automated text message reminder was sent to the participant	meter in validation study Subjective: self-reported PA with paper diary and mobile phone–based diary in pilot study; self-reported PA with mobile phone–based diary and retro-spective California Mens' Health Study PA question-naire		mobile phone–based diary; validity of PA measurement by mobile phone–based diary vs accelerometer, questionnaires, physical fitness, and body fat	2. 59.6% of users reported they preferred the mobile phone diary over the paper diary 3. Intraclass correlations for light and vigorous activity from mobile diary were 0.55 and 0.63, respectively 4. Correlations between PA estimates from the mobile diary and validation criteria were moderate	
Toscos (2006)[22]	7	Age, years, M±SD: 14.7 (SD not reported) Female: 100% Ethnicity: not reported Mean BMI±SD: not reported Country: not reported	Design: quasi-experimental Purpose: motivate adolescent girls to exercise by increasing their awareness of their activity levels and utilizing their desire to be socially connected to friends and peers Length: 4 days	Chick Clique mobile phone app allowed participants to enter step counts, share activity levels, and compare activity levels with peers; app included food tips tool that provided nutrition information for fast-food chains and calculated step count needed to compensate for consumption of empty calories; SMS	Objective: N/A Subjective: self-reported pedometer data	Fogg's functional view of persuasive technology as a tool that persuades by increasing self-efficacy of user	Step count; usability and acceptability of the Chick Clique app	High school participants had more steps using Chick Clique + pedometer than pedometer alone; middle school participants had more steps using the pedometer alone than using Chick Clique + pedometer (significance not reported)	Weak

Study	N	Sample characteristics	Study characteristics	Mobile technology use	PA measure-ment	Theoretic basis	Main outcomes	Findings	Study quality
				messages for participants to communicate PA to peers using the app and to prompt discussion about group exercise plans and goals; automated SMS messages sent indicating group performance and individual fitness level achieved; encouraging messages offering praise for reaching step goals sent					

App, application; EE, energy expenditure; EMA, Ecologic Momentary Assessment; IPAQ, International Physical Activity Questionnaire; IVR, interactive voice response; MVPA, moderate-to-vigorous physical activity; PA, physical activity; SMS, short message service

Note: For intervention studies, study quality was assessed as strong if no weak ratings, moderate if one weak rating, and weak if two or more weak ratings for the following study characteristics: selection bias, study design, confounders, blinding, data collection method, withdrawals and dropouts. For non-intervention studies, study quality was assessed as strong if no weak ratings, moderate if one weak rating, and weak if two or more weak ratings for the following study characteristics: selection bias, data collection method, and withdrawals and dropouts.

References for Appendix A

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