

5-2022

Utilizing RE-AIM to Assess Adolescent Weight Loss Interventions: A Systematic Review

Jordan McCullough
University of Nebraska Medical Center

Follow this and additional works at: https://digitalcommons.unmc.edu/coph_slce



Part of the [Public Health Commons](#)

Recommended Citation

McCullough, Jordan, "Utilizing RE-AIM to Assess Adolescent Weight Loss Interventions: A Systematic Review" (2022). *Capstone Experience*. 188.

https://digitalcommons.unmc.edu/coph_slce/188

This Capstone Experience is brought to you for free and open access by the Master of Public Health at DigitalCommons@UNMC. It has been accepted for inclusion in Capstone Experience by an authorized administrator of DigitalCommons@UNMC. For more information, please contact digitalcommons@unmc.edu.

Utilizing RE-AIM to Assess Adolescent Weight Loss Interventions: A Systematic Review

Jordan McCullough

Concentration: Health Promotion

Capstone Committee:

Melissa Tibbits, PhD (Chair)

Paul Estabrooks, PhD

Fabio Almeida, PhD

Abstract: Adolescent overweight/obesity is an ongoing concern for public health professionals. One out of every five adolescents are overweight, and one out of every three is at risk. Adolescent overweight/obesity is associated with a higher chance of overweight/obesity, premature death, and disability in adulthood. A 2018 systematic review by Moores et al. compared the effectiveness of community-based treatment programs for adolescents (13-17 years) who are overweight and obese by comparing pre-program to post-program changes in weight-related measurements and health-behavior changes. While looking at the effectiveness of a program provides valuable information, other elements (i.e., representativeness of participants, implementation measures such as cost, and the ability to sustain the intervention overtime) should also be incorporated in the evaluation process. Evaluating interventions based on its reach, effectiveness, adoption, implementation, and maintenance (RE-AIM) will provide a more comprehensive understanding of the ability to translate the study into a “real-world” setting. Using a RE-AIM coding tool for evaluation, this review expands on previous findings and provides public health professionals, local schools, and health departments with the information that is needed when implementing their own weight loss interventions for adolescents. This systematic literature review evaluated interventions published between January 2016 to December 2021.

Chapter 1 – Introduction

Research Question & Objectives

This systematic literature review was conducted to explore different weight loss interventions for adolescents by using the RE-AIM framework as a tool for evaluation (RE-AIM, n.d.). A previous 2018 article by Moores et al. titled “A systematic review of community-based interventions for the treatment of adolescents with overweight and obesity” was utilized as a guideline, and the findings from the article were expanded on using a RE-AIM coding tool. RE-AIM is one framework used to encourage program planners, evaluators, researchers, funders, and policy-makers to pay more attention to essential program elements that can improve the sustainable adoption and implementation of effective, generalizable, evidence-based interventions (RE-AIM, n.d.). Evaluating interventions based on their reach, effectiveness, adoption, implementation, and maintenance will provide a more realistic idea on how interventions can be translated from research into practice. In the 2018 article, a comprehensive and systematic literature search was conducted consisting of published articles from January 2011 to March 2017 (Moores, 2018). In this review, the same search strategies provided by Moores et al. are utilized to evaluate interventions published from January 2016 to December 2021.

The purpose of this review is to highlight the need for community-based weight loss interventions to go beyond reporting the effectiveness of the program. Many existing publications, including the Moores et al. systematic review, focus on program effectiveness, yet it is unclear whether or not all the RE-AIM indicators are measured. While program effectiveness is crucial information to report, individuals and organizations need to know other key program elements before implementing a similar intervention in a real-world setting. Based

on recent literature, the question to be explored in this review is: How many of the RE-AIM indicators are addressed in community-based weight loss interventions for overweight/obese adolescents? The five indicators used in the framework offer realistic strategies to help translate research into practice (RE-AIM, n.d.). Having information regarding a program's reach, effectiveness, adoption, implementation, and maintenance can lead to more programs being implemented into a community setting which will ultimately have a greater public health impact.

Chapter 2 – Background

Description of the Health Problem

According to the World Health Organization, overweight and obesity are defined as an abnormal or excessive fat accumulation that presents a risk to health. In adults, a body mass index (BMI) over 25 is considered overweight, and a BMI over 30 is obese (WHO, 2014). BMI is an inexpensive and easy form of screening for overweight/obesity and weight related health problems. For adults, it can be calculated by using an individual's weight and height ($BMI = \text{weight (kg)} / [\text{height (m)}]^2$). Since weight and height changes drastically during childhood and adolescence, their BMI must be interpreted differently than adults. Instead, BMI scores for children and adolescents must be measured relative to children of the same sex and age. In children and teens, BMI is age- and sex-specific and is often referred to as BMI-for-age (CDC, 2021a). Adolescents who fall between the 85th to less than the 95th percentile are considered overweight and those who are equal to or greater than the 95th percentile would be considered obese. For children and teens, BMI is not a diagnostic tool (CDC, 2021b). Instead, BMI is used to screen for potential weight and other health-related issues that are likely to occur.

Impact of Overweight/Obesity on Health

Overweight/obesity can affect adolescent health in a number of ways. Being overweight increases the risk of developing diabetes, heart disease, high blood pressure, and cancer, among other adverse outcomes (Wile Schwarz, 2010). The longer a person is obese, the more significant obesity-related risk factors become (Hopkins., n.d.). Without screening and early intervention, overweight adolescents are more likely to become overweight adults compared to their normal weight peers (Wile Schwarz, 2010).

Along with individual health and well-being implications, adolescent overweight/obesity in the United States has economic implications. Excess medical costs due to overweight adolescents are estimated at more than \$14 billion per year (Wile Schwarz, 2010). According to 2017-2018 data from the National Health and Nutrition Examination Survey (NHANES) among adolescents ages 12 to 19, more than 1 in 5 (21.2%) are obese (NIDDKAKidney, 2021). An estimated decrease by 1% of adolescents who suffer from overweight or obesity could save between \$463 ad \$691 million in long-term health care cost (Wang et al., 2010). The prevalence highlights the need for effective, long-term treatment of adolescent obesity.

Intervening in Adolescence

Adolescence is the developmental period between childhood and adulthood (WHO, n.d.). Adolescence begins with the onset of puberty and ends when an adult identity and behavior are accepted. This period of development corresponds roughly to the period between the ages of 10 and 19 years (Society, 2003).

Adolescence is a pivotal time for behavioral and lifestyle modifications. Adolescents experience rapid physical, cognitive, and psychosocial growth that affects how they feel, think, make decisions, and interact with the world (WHO, n.d.). Other than the first year of life, there is no other developmental period during which individuals grow more than during adolescence.

These years are the time to form positive habits that will improve adolescents' long-term health and well-being (OPA, n.d.).

Weight loss interventions for adolescents have the potential to combat the ongoing obesity epidemic in the United States as well as the economic impact it has on the country. A 2016 Report of the World Health Organization Commission on Ending Childhood Obesity recommends the provision of 'family-based, multicomponent, lifestyle weight management services for children and young people who are obese' as part of universal child and adolescent healthcare (WHO, 2016). When selecting the most appropriate program for their community, individuals and organizations must consider a number of factors. In adolescence, weight loss has been positively associated with behavioral strategies such as increasing physical activity, drinking less soda, and watching less television (Boutelle et al., 2009). Socio-environmental factors, such as parent and peer support, modeling behaviors, and parents making positive changes to the home environment have also been identified as important for adolescent weight loss (Watts et al., 2016). Addressing these factors early in the life span is key in targeting the prevalence of obesity in adults.

RE-AIM

When looking for long-lasting and effective interventions, the RE-AIM framework is one mechanism public health professionals can use to determine what programs work in a real-world environment and are worth sustained investment (Glasgow, 1999). RE-AIM is an acronym used to describe the Reach, Effectiveness, Adoption, Implementation, and Maintenance of an intervention. The reach refers to the absolute number, proportion, and representativeness of individuals who participate in each initiative, intervention or program, and reasons why or why not. Effectiveness (sometimes efficacy) means the impact that the intervention has on important

outcomes, which may be positive or negative. Adoption can help program planners identify the support and resources needed at the staff and setting level to implement an intervention. Lastly, implementation and maintenance look at the delivery and sustainability of the intervention. These two elements make sure the delivery of the intervention is consistent in both time and cost and look at the long-term effect the program has on observable health outcomes after the conclusion of the intervention (RE-AIM, n.d.). Each element of the framework is important by itself, but when used together, the five components can help point out strengths and weaknesses of different approaches and help determine successful strategies in weight loss interventions for adolescents. Given the importance of the five elements of the RE-AIM framework, this review will assess how many of the five RE-AIM indicators are addressed in community-based weight loss interventions for overweight/obese adolescents.

Chapter 3 – Methods

Search Strategies

A systematic literature search was conducted utilizing the following literature databases: Medline, CINAHL, and Embase. The search strategy used was modeled off of the Moores et al. review (Appendix A). Database searches were restricted to literature published between January 2016 and December 2021 to ensure this review analyzed different articles than the original review.

Inclusion and Exclusion Criteria

As per the Moores et al. review, all studies were assessed according to the following inclusion and exclusion criteria:

1. Participants who are adolescents (between 13 and 17 years old) at the start of the intervention and considered to be overweight or obese. More specifically, the studies were included where:
 - a. It specified the in the study that participants were within the ages of 13-17 years;
 - b. A sub-group in the study was reported with the ages of 13-17 years; or
 - c. The mean age of participants was between 13 and 17 years.
2. Intervention(s) that are based in the community and target overweight or obese adolescents. Any form of intervention delivery were included (e.g., face-to-face; online; use of cell phones or a combination). Programs had to incorporate a group element (i.e., not solely one-on-one delivery), unless done via technology.
3. All designs studies (i.e., randomized controlled-trials, case-control studies, and pre-post-controlled studies) were included.
4. The primary outcomes were related to pre/post-program changes (e.g., weight-related measures such as BMI or weight). The secondary outcomes were changes in behavior (e.g., diet-, activity-, sedentary-related), self-esteem, and quality of life.
5. Interventions that were not related to the treatment of overweight/obesity among adolescents will be excluded from this review. Studies will not be included if they are not applicable to otherwise healthy adolescent populations, not applicable to a high-income country setting, and/or when a full text article is not in English.

Data Extraction & Quality Assessment

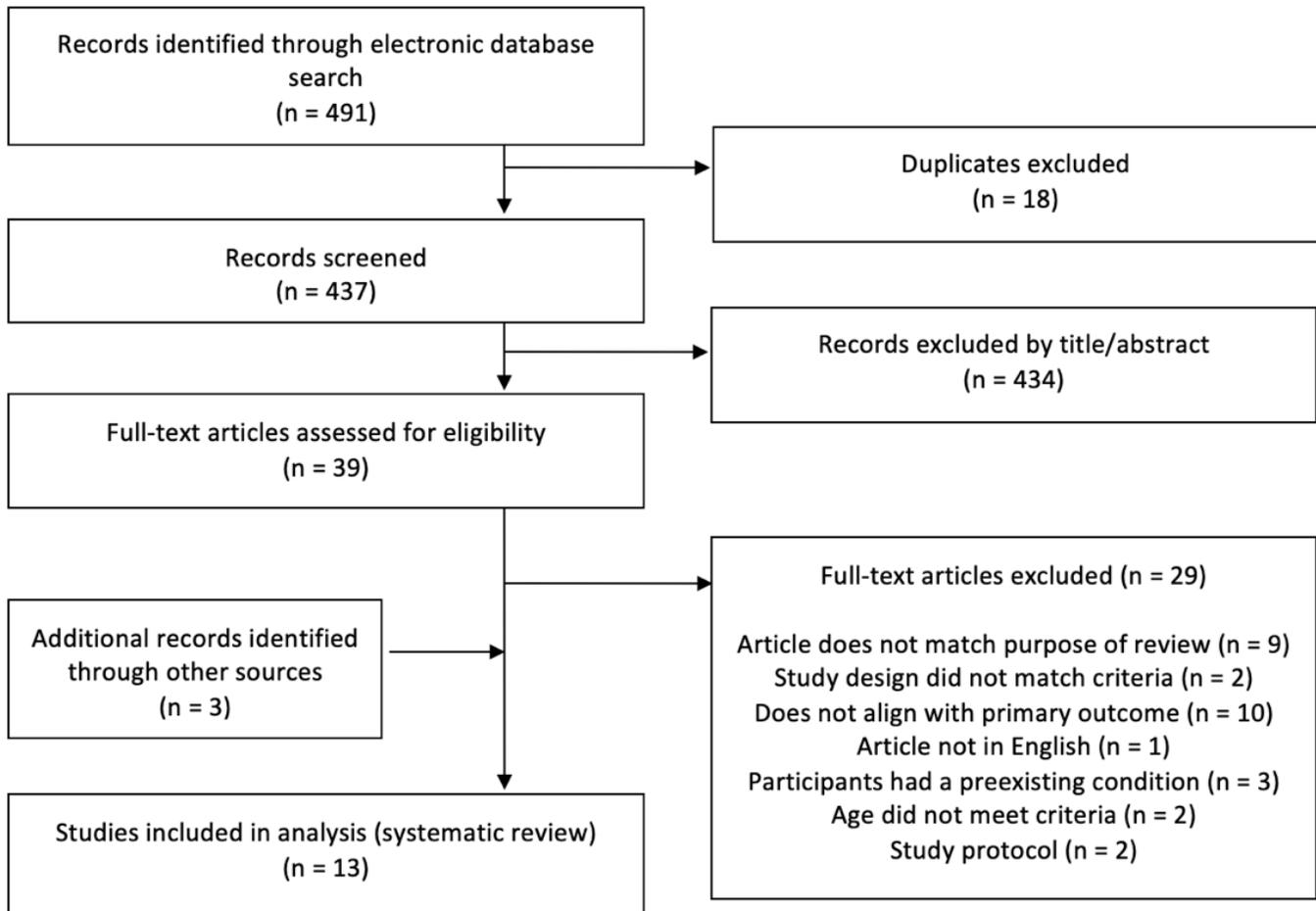
Once all eligible studies were identified, the data for the five components of the RE-AIM framework were extracted using a coding tool adapted from a 2019 article titled “Rural physical

activity interventions in the United States: a systematic review and RE-AIM evaluation” by Bhuiyan et al (Appendix B). The extracted data also included the year the article was published, study setting, study design and goal, as well as duration of the intervention. For each of the five dimensions, the presence or absence was coded (yes/no), and if present, a description of the indicator was extracted (Bhuiyan, 2019).

Chapter 4 – Results

Search Results and Selection Process

The literature searches in CINAL, Medline, and Embase presented 491 potentially relevant articles. After the duplicates were removed, the remaining articles titles and abstracts were screened using the eligibility criteria. Once the records were excluded by title and abstract, a final full-text review of the remaining potential articles was performed. Figure 1 shows the selection process in the Preferred Reporting Items for Systematic Reviews (PRISMA) flow diagram (Page et al., 2021). There was a total of 13 full-text articles included for review and data extraction.

Figure 1. Preferred Reporting Items for Systematic Reviews (PRISMA) Flow Diagram

Description of Studies

Study, program, and participant characteristics are reported in Table 1. Many of the programs were from the United States (US; $n = 7$) with the remainder from Australia ($n = 2$), United Kingdom (UK; $n = 1$), Brazil ($n = 1$), France ($n = 1$), and Canada ($n = 1$). The programs were evaluated as controlled trials ($n = 9$), both randomized ($n = 8$) and non-controlled ($n = 1$), and clinical trials ($n = 4$).

The number of participants in the program ranged from 16 to 411, with the average sample size of 107. Most of the programs ($n = 9$) solely focused on overweight or obese adolescents while the remaining four programs introduced parent/caregiver involvement. Study duration varied from 5 weeks to 8 months and only a small portion ($n = 9$) of the studies included a follow-up after the program concluded.

Table 1. Study Characteristics

| Author/Year | Country | Study Goal | Study Design | Sample Size | Age; mean (SD) | Parent/Caregiver Involvement | Intervention Duration | Includes Technology | Follow-up (after baseline) |
|----------------------------|----------------|-----------------------------------|------------------------------|-------------|--|------------------------------|-----------------------|--------------------------------------|----------------------------|
| Bonham et. al., 2017 | Australia | Weight loss | Multisite parallel-group RCT | 88 | IC 13-17; mean (SD) 15.3 (1.3) | -- | 12 weeks | -- | 36 weeks |
| Bowen-Jallow et. al., 2021 | USA | Weight loss | Pilot RCT | 48 | IC 12-18; mean (SD) 14.8 (1.7) | -- | 18 weeks | Fitbit Alta | -- |
| Chen et. al., 2018 | USA | Weight loss | Pilot RCT | 42 | IC 13-18; mean (SD) 14.9 (1.7) | -- | 3 months | Smartphone, Fitbit Flex | 6 months |
| Gustafson et. al., 2019 | USA | Fruit/Veggie intake & weight loss | RCT | 411 | IC 14-16; mean (SD) 15 (0.07) | -- | 8 weeks | Text messages/video calls | -- |
| Hadley et. al., 2020 | USA | Weight loss | Pilot RCT | 38 | IC 13-17; mean (SD) 14.7 (1.4) | Yes | 16 weeks | -- | 4 months |
| Jebeile et. al., 2019 | Australia | Weight loss | Noncontrolled trial | 30 | IC 12-17; mean (SD) 14.5 (1.4) | -- | 26 weeks | Test messages, Fitbit One | -- |
| Jensen et. al., 2016 | USA | Weight loss | Pilot clinical | 16 | IC 13-17; mean (SD) 14.3 (1.1) | Yes | 24 weeks | iPhone 4, diet/physical activity app | -- |
| Kulendran et. al., 2016 | United Kingdom | Weight management/loss | Pilot RCT | 27 | Intervention group mean age 13.7; commitment group mean age 13.8 | -- | 12 weeks | Text messages | -- |
| Leme et. al., 2016 | Brazil | Weight loss | RCT | 253 | 14-18; mean (SD) 16.32 (0.06) | -- | 6 months | -- | -- |
| Rey et. al., 2017 | France | Weight loss | Clinical trial | 24 | IC 14-15 | -- | 5 weeks | -- | -- |
| Tu et. al., 2017 | Canada | Weight loss | Clinical trial | 159 | IC 11-16; mean (SD) 13.2 (1.8) | Yes | 8 months | MySteps (e-health) | -- |
| Vidmar et. al., 2019 | USA | Weight loss | Clinical trial | 18 | IC 12-18; mean 14.4 | -- | 6 months | iPhone 5S, W8Loss2Go app | -- |
| Wilson et. al., 2021 | USA | Weight loss | Group cohort RCT | 241 | IC 11-16; mean (SD) 13.0 (1.8) | Yes | 16 weeks | -- | 6 months |

Abbreviations: United States of America (USA), Randomized Control Trial (RCT), Inclusion Criteria (IC), Standard Deviation (SD)

Table 2. RE-AIM Framework Indicators and Number of Times Reported

| Indicator | Number reported (%) |
|---|----------------------------|
| Reach | |
| Method to identify target population | 7 (54%) |
| Demographic & behavioral information | 13 (100%) |
| Recruitment strategies | 13 (100%) |
| Inclusion criteria | 11 (85%) |
| Exclusion criteria | 7 (54%) |
| # eligible and invited (exposed) | 10 (77%) |
| Sample size | 13 (100%) |
| Participation rate | 10 (77%) |
| Cost of recruitment | 2 (15%) |
| Efficacy/Effectiveness | |
| Weight change | 13 (100%) |
| Quality of life measure | 5 (38%) |
| Measure unintended consequences (negative) and result | 2 (15%) |
| Percent attrition (at program completion) | 6 (46%) |
| Cost effectiveness | 0 (0%) |
| Use of qualitative methods to measure efficacy/effectiveness | 5 (38%) |
| Adoption – Setting Level | |
| # eligible and invited (exposed) | 1 (8%) |
| # participating | 3 (23%) |
| Participation rate | 1 (8%) |
| Description of targeted location | 4 (31%) |
| Inclusion/exclusion criteria of setting | 1 (8%) |
| Description of intervention location | 5 (38%) |
| Method to identify setting | 5 (38%) |
| # of comparisons | 2 (15%) |
| Average # of persons served per setting | 2 (15%) |
| Adoption – Staff Level | |
| # eligible and invited (exposed) | 0 (0%) |
| # participating in delivery | 1 (8%) |
| Participation rate | 3 (23%) |
| Level of expertise of delivery agent | 11 (85%) |
| Measure of cost of adoption | 1 (8%) |
| Use of qualitative methods to measure adoption | 6 (46%) |
| Implementation | |
| Use of theory to guide intervention | 4 (31%) |
| Intervention number of contacts | 13 (100%) |
| Timing of contacts | 11 (85%) |
| Duration of contacts | 11 (85%) |
| Extent protocol delivered as intended (%) | 0 (0%) |
| Consistency of implementation across setting and delivery agents | 4 (31%) |
| Participant attendance/completion rates | 10 (77%) |
| Measure of cost | 1 (8%) |
| Use of qualitative methods to measure implementation | 7 (54%) |
| Maintenance | |
| Was individual weight assessed at some duration following the completion of intervention? (Give duration follow-up) | 4 (31%) |
| Attrition | 3 (23%) |
| Use of qualitative methods to measure individual maintenance | 0 (0%) |
| Description of program continuation | 0 (0%) |

Summary of Findings

Table 2 displays the results after coding for the different RE-AIM indicators and the number of times they were reported in the selected articles.

REACH

Reach was the most reported principle in the RE-AIM framework which provided more information about the participants that were included. All the studies included demographic and behavioral information (i.e., gender, age, race/ethnicity) for the participants. Since the target was adolescents, further information about the family (i.e., educational attainment, occupation, socioeconomic status) was also included. All but one study identified their recruitment strategies to reach the target population. Most of the participants were recruited through referrals from a pediatric clinic or by attending a certain school that met the inclusion criteria for the setting. Three studies (Jensen et al., 2016; Tu et al., 2017; Wilson et al., 2021) used additional recruitment strategies that involved different forms of online and paper advertisements along with mailed invitations. The least reported indicator for reach was the cost of recruitment. Very few stated the financial aspect of the recruitment process.

Inclusion criteria was explicitly stated in 11 of the 13 included studies. This criteria aligned with what was presented in the Moores et. al review. To be included, the participants had to be considered adolescents (each study included a different age range) and had to have a BMI above a certain threshold. Since participants were minors, some required parent/guardian and adolescent consent to participate (Jensen et al., 2016). Exclusion criteria was only included 7 of the studies. Common reasons for exclusion included an existing co-morbidity, use of medication that would affect body weight, involvement in another weight loss intervention, and lack of parental consent.

Sample size was reported in all the studies with a range of 16 to 411 participants and average sample of 107. However, many of the studies (n = 9) included less than 100 participants. The participation rate was either explicitly stated or enough information was provided (number of people who agreed to participate/number of eligible participants contacted for participation) to calculate the rate for 10 of the different studies.

EFFICACY

Participant weight outcomes from baseline to conclusion for each intervention is further assessed in Table 3. Although there was mixed success between the different interventions, all the studies included the degree of weight change even if the difference reported was not significant. A minority of the studies (n = 5) also measured broader impacts such as measures of quality of life. Less than half of the interventions (n = 6) included the percentage of individuals who dropped out or were lost to follow up at the conclusion of the intervention. Reasons given for ending participation include the following: lost interest/difficulty engaging individuals, parental dependence, undergoing surgery (not related to study), absent on testing day, or refusing to be measured.

Only two studies (Bonham et al., 2017; Leme et al., 2016) reported that there were “no adverse effects reported.” While the rest failed to mention any adverse effects, even if there were none reported. None of the studies reported the cost effectiveness of the intervention.

Table 3. Difference in Weight from Baseline to Conclusion of Intervention

| Study | Weight change in BMI (kg/m ²) | Duration of Intervention |
|---------------------|--|--------------------------|
| Bonham et. al | -2.1 kg/m ² (intervention – JennyCraig) 0.4 kg/m ² (wait-list control) | 12 weeks |
| Bowen-Jallow et. al | -0.25 kg/m ² (ATI group) -2.77 kg/m ² (control) | 18 weeks |
| Chen et. al | -2.54 kg/m ² (Fitbit, educational material, text messages) 0.46 kg/m ² (control: pedometer and blank food-and-activity diary) | 3 months |
| Hadley et. al | -0.58 kg/m ² (skill training and application) 0.03 kg/m ² (emotional regulation) | 16 weeks |
| Kulendran et. al | 1.06 kg/m ² (information group) -0.12 kg/m ² (commitment group) | 12 weeks |
| Leme et. al | -1.33 kg/m ² (H3G – Brazil) -1.21 kg/m ² (control) | 6 months |
| Rey et. al | -1.17 kg/m ² (girls physical fitness intervention) -1.52 kg/m ² (boys physical fitness intervention) | 5 weeks |
| Study | Weight change in weight (kg) | Duration of Intervention |
| Vidmar et. al | -2.2 kg (app group) -1.7 kg (EMPOWER group) | 6 months |
| Study | Weight change in weight (z-score) | Duration of Intervention |
| Jebeile et. al | -0.13 (VLED, eating plan, visits, phone/email/SMS support) | 26 weeks |
| Jensen et. al* | -0.07 (Smartphone/Daily Burn Tracker intervention) | 12 weeks |
| Wilson et. al | -0.14 (family weight loss) | 16 weeks |
| Study | Weight change in BMI z-score (percentile) | Duration of Intervention |
| Gustafson et. al | -0.005 (weekly text messages) 0.002 (control) | 8 weeks |
| Tu et. al | -0.007 (participation) | 8 months |

Abbreviations: Body Mass Index (BMI); kilograms (kg); meters (m); activity tracker intervention (ATI); pounds (lbs); “Healthy Habits, Healthy Girls” (H3G); very-low energy diet (VLED)

ADOPTION – SETTING/STAFF

Relative to the other principles, adoption at both levels (setting and staff) had the most underreported indicators for the RE-AIM framework. The number reported in Table 2 for adoption at the setting level was never above 50%. Only one study (Leme et al., 2016) included the number of sites that were eligible and invited, the number of participating sites, the participation rate, and inclusion/exclusion criteria of the setting. Although some interventions

took place in the participants home, only 5 of the included studies explicitly described the intervention location and the method to identify the setting. There was one study (Vidmar et al., 2019) that provided a cost analysis of adopting an app intervention (facility fee = \$50.00 per encounter/\$150 per patient) versus a current intervention (facility fee = \$50 per encounter/\$300 per patient).

At the staff level, the most reported indicator was the level of expertise of delivery agent. In addition to a registered dietitian two of the studies stated having a trained consultant (Bonham et al., 2017; Chen et al., 2019) and one reported having a trained research assistant (Hadley et al., 2020) although no further explanation of the level of expertise a “trained” assistant had. One study mentioned the human nutrition and dietetics undergraduate students participated in an hour-long training about how to effectively send text messages as the mentor via the Group Me app (Gustafson et al., 2019).

IMPLEMENTATION

All the studies included information about the number of contacts in each of the interventions. A majority provided more detail about the duration and timing of the contacts. Two of the studies (Chen et al., 2019; Leme et al., 2016) stated the use of the Social Cognitive Theory (SCT) to base the intervention from. Tu et. al used SCT as well as the Transtheoretical Model (TTM) and Wilson el. al integrated elements of SCT, Self-Determination Theory, and Family Systems Theory to target weight-related outcomes. Only 10 studies included the participant attendance/completion rates.

The most underreported indicators were the cost of implementation and the extent the protocol was delivered as intended or fidelity of the intervention. In the same cost analysis presented in Vidmar et. al, the total cost for the app intervention was estimated at \$1,011.82

compared to \$1,427.78 for the existing EMPOWER intervention. However, the app intervention included more contacts with the provider staff, a smartphone/data plan, and app maintenance. A few studies mentioned delivering a standardized test or using video to maintain consistency across the intervention, yet none of the studies explored the fidelity of the intervention protocol.

MAINTENANCE

Along with efficacy and adoption, maintenance was underreported in all 13 of the studies. Only 4 included some form of follow-up to assess participant weight after the conclusion of the intervention. One intervention assessed the acceptability to participants and families at the end of the 26 weeks, and found they rated the plan as “easy” and “pleasant” to follow. All participants would recommend the diet to other young people and thought they could follow it long term for 6 months (79%), 12 months (58%), and 18 months (58%) (Jebeile et al., 2019). Yet no follow-up was actually performed to see if the participants followed the diet plan long-term. Reasons why participants were lost at different follow-up points during the intervention include difficulty engaging individuals, parental dependence, absent on testing day, and refusing to be measured.

Quality Assessment

As stated in the inclusion criteria, the primary outcomes were related to pre/post-program changes (e.g., weight-related measures such as BMI or weight). The secondary outcomes were changes in behavior (e.g., diet-, activity-, sedentary-related), self-esteem, and quality of life. Table 4 outlines weight as the primary measure included in each of the studies, as well as additional measures that were used to address individual weight change.

Table 4. Primary and Secondary Outcomes Addressed in Interventions

| Author/Year | Weight Measure | Physical Activity | Sedentary Behavior | Screen Time | Diet/Eating Behavior | Quality of Life Measures | Self-Efficacy/Goal Setting |
|----------------------------|----------------|-------------------|--------------------|-------------|----------------------|--------------------------|----------------------------|
| Bonham et. al., 2017 | X | X | X | | X | X | X |
| Bowen-Jallow et. al., 2021 | X | X | X | | | | |
| Chen et. al., 2018 | X | X | X | | X | X | X |
| Gustafson et al., 2019 | X | | | | X | | X |
| Hadley et. al., 2020 | X | X | | | X | X | X |
| Jebeile et. al., 2019 | X | X | | X | X | X | |
| Jensen et. al., 2016 | X | X | | | X | | |
| Kulendran et. al., 2016 | X | | | | X | | |
| Leme et. al., 2016 | X | X | | X | X | | |
| Rey et al., 2017 | X | X | | | | | X |
| Tu et. al., 2017 | X | X | | X | X | X | X |
| Vidmar et. al., 2019 | X | | | | X | | X |
| Wilson et. al., 2021 | X | X | | X | X | | X |

Chapter 5 – Discussion

Summary

RE-AIM is a framework used to guide the planning and evaluation of programs according to the 5 key outcomes: Reach, Efficacy, Adoption, Implementation, and Maintenance (RE-AIM, n.d.). The overall goal of the RE-AIM framework is to encourage program planners, evaluators, researchers, funders, and policy-makers to pay more attention to essential program elements including external validity that can improve the sustainable adoption and implementation of effective, generalizable, evidence-based interventions (RE-AIM, n.d.).

In this study, the most reported RE-AIM outcomes were reach and implementation. All of the eligible studies included participant demographic information and the recruitment strategies used to attract them. Each study reported the sample size and a majority either explicitly stated the participation rate, or enough information was given to calculate the percentage. The studies all made mention of the number of contacts within the intervention and a majority reported on the timing of the contacts and the duration. Participant attendance/completion rates were also reported on in a majority of the studies.

The least reported RE-AIM outcomes were efficacy/effectiveness, adoption at both levels, and maintenance. Aside from all studies making mention of pre- and post-intervention weight status, efficacy indicators such as quality of life measures, unintended consequences, and percent attrition were reported in less than half of the studies. For adoption at the setting level, only one study reported on the number of eligible/exposed sites for implementation and three stated the number of participating locations. Indicators such as description of targeted location, description of intervention location, and average number of persons served per location were only reported in a few studies. At the staff level, none of the eligible studies reported on the

number of eligible/exposed staff required to implement the intervention and one included the number that participated in the delivery. Indicators regarding the continuation of the different programs and methods to measure individual maintenance were not reported in any of the interventions included in this study.

Across all RE-AIM outcomes, reporting on the cost associated with different program elements was poor. For reach, the cost of recruitment was only included in two studies and none reported on the cost effectiveness of the intervention. Of the 13 studies, only one (Vidmar et al., 2019) included a cost analysis which included key elements pertaining to the financial components of the program versus one that was already in place.

Public Health Implications

Community-based weight loss interventions that report on reach, effectiveness, adoption, implementation, and maintenance have the potential to have major public health implications for adolescents. Factors such as effectiveness of the program for the target population, along with its applicability, generalizability within the community are components for individuals and organizations to know prior to selecting the most appropriate program. Additional details such as personnel, cost, setting, program scale and sustainability can determine the feasibility of delivering a program in the community. Including information about RE-AIM components allows for individuals and organizations to have a deeper understanding about their own ability to implement a program into their community. Weight loss interventions for adolescents have the potential to not only address their current weight status, but can help to create positive health behaviors in the future. Setting up positive health behaviors during this developmental period can help to combat the ongoing obesity epidemic.

Strengths and Limitations

Along with modeling this review off of a previous publication over adolescent overweight/obesity programs, a list of RE-AIM framework indicators presented by Bhuiyan et. al was utilized to assesses each study to get a complete picture on the representiveness current interventions address different RE-AIM outcomes. The merge of different reviewed and published articles provided a good foundation for this review.

One limitation of this review (and other similar studies) comes from the focus on adolescents as the participants. Because adolescents are minors and considered dependent, parental/caregiver consent plays a major factor in the ability to reach and enroll participants. This contributed to the smaller sample size in a majority or the studies and why there was participant drop out. Since most studies had a sample size less than 100, it is hard to generalize the results to a larger population.

Another potential limitation of the review is the literature search only consisted of three different databases. This limited the number of potentially relevant articles that could have been assessed and included in the review. After screening the articles produced by the literature search, only 13 met the criteria to be included in the analysis.

Gaps in Evidence

Despite the importance of addressing obesity during adolescents, it remains an understudied area compared with the focus on adults of school-age children (Hadley et al., 2020). More studies need to address overweight/obesity during adolescents to grow the amount of research done for this particular age. Many studies that appeared in the literature search looked at gastric bypass or bariatric surgeries as a form of weight loss for adolescents instead of behavioral modifications. While surgery is a form of a weight loss intervention, it is costly and

not an option many individuals can take. Interventions that incorporate behavioral components are easier to reach more individuals.

Along with the lack of focus on obesity during adolescents, there is even less attention on the importance of family and parental involvement for this age. Since adolescents are dependent, their behavior and actions after the conclusion of an intervention are heavily influenced by what they are surrounded by after a program. In this review, only 31% of the studies included at least one parent or caregiver in the intervention.

Conclusions

Many publications, including a recent systematic review on community-based weight loss interventions, focus on the program effectiveness, yet it is unclear how many of these publications report on RE-AIM components. When it comes to program planning and evaluation, it is important to analyze and report on the dimensions of the RE-AIM framework in order to enhance adoption and implementation of evidence-based interventions into the community.

Bibliography

- Bhuiyan, N., Singh, P., Harden, S., & Mama, S. (2019). Rural physical activity interventions in the United States: a systematic review and RE-AIM evaluation. *International Journal of Behavioral Nutrition and Physical Activity*. <https://doi.org/https://doi.org/10.1186/s12966-019-0903-5>
- Bonham, M. P., Dordevic, A. L., Ware, R. S., Brennan, L., & Truby, H. (2017). Evaluation of a Commercially Delivered Weight Management Program for Adolescents. *Journal of Pediatrics*, *185*, 73-80.e73. <https://doi.org/10.1016/j.jpeds.2017.01.042>
- Boutelle, K. N., Libbey, H., Neumark-Sztainer, D., & Story, M. (2009, Dec). Weight control strategies of overweight adolescents who successfully lost weight. *J Am Diet Assoc*, *109*(12), 2029-2035. <https://doi.org/10.1016/j.jada.2009.09.012>
- CDC. (2021a). *About Child & Teen BMI*. https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.htm
- CDC. (2021b). *CDC Healthy Schools: Obesity*. <https://www.cdc.gov/healthyschools/obesity/index.htm>
- Chen, J. L., Guedes, C. M., & Lung, A. E. (2019, Apr). Smartphone-based Healthy Weight Management Intervention for Chinese American Adolescents: Short-term Efficacy and Factors Associated With Decreased Weight. *J Adolesc Health*, *64*(4), 443-449. <https://doi.org/10.1016/j.jadohealth.2018.08.022>
- Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the Public Health Impact of Health Promotion Interventions: The RE-AIM Framework. *American Journal of Public Health*, *89*(9), 1332-1327.
- Gustafson, A., Jilcott Pitts, S. B., McQuerry, K., Babtunde, O., & Mullins, J. (2019). A Mentor-Led Text-Messaging Intervention Increases Intake of Fruits and Vegetables and Goal Setting for Healthier Dietary Consumption among Rural Adolescents in Kentucky and North Carolina, 2017. *Nutrients*, *11*(3), 593-593. <https://doi.org/10.3390/nu11030593>
- Hadley, W., Houck, C., Barker, D., Wickham, B., Bogner, J., & Jelalian, E. (2020). Preliminary Impact of an Adapted Emotion Regulation Intervention for Adolescents with Overweight and Obesity Attempting to Lose Weight. *Journal of Developmental & Behavioral Pediatrics*, *41*(9), 706-715. <https://doi.org/10.1097/DBP.0000000000000837>
- Hopkins., J. (n.d.). *Preventing Obesity in Children, Teens, and Adults*. <https://www.hopkinsmedicine.org/health/conditions-and-diseases/obesity/preventing-obesity>

- Jebeile, H., Gow, M. L., Lister, N. B., Mosalman Haghghi, M., Ayer, J., Cowell, C. T., Baur, L. A., Garnett, S. P., & Mosalman Haghghi, M. (2019). Intermittent Energy Restriction Is a Feasible, Effective, and Acceptable Intervention to Treat Adolescents with Obesity. *Journal of Nutrition*, 149(7), 1189-1197. <https://doi.org/10.1093/jn/nxz049>
- Jensen, C. D., Duncombe, K. M., Lott, M. A., Hunsaker, S. L., Duraccio, K. M., & Woolford, S. J. (2016). An Evaluation of a Smartphone–Assisted Behavioral Weight Control Intervention for Adolescents: Pilot Study [Original Paper]. *JMIR Mhealth Uhealth*, 4(3), e102. <https://doi.org/10.2196/mhealth.6034>
- Kidney, N. I. o. D. a. D. a. (2021). Overweight & Obesity Statistics. *National Institute of Health*. <https://www.niddk.nih.gov/health-information/health-statistics/overweight-obesity>
- Leme, A. C. B., Lubans, D. R., Guerra, P. H., Dewar, D., Toassa, E. C., & Philippi, S. T. (2016, 2016/05/01/). Preventing obesity among Brazilian adolescent girls: Six-month outcomes of the Healthy Habits, Healthy Girls–Brazil school-based randomized controlled trial. *Preventive Medicine*, 86, 77-83. <https://doi.org/https://doi.org/10.1016/j.ypmed.2016.01.020>
- Moore, C. J., Bell, L.K., Damarell, R.A., Matwiejczyk, L., & Miller, M.D. (2018). A systematic review of community-based interventions for the treatment of adolescents with overweight and obesity. *Obesity Review*. <https://doi.org/10.1111/obr.12660>
- OPA. (n.d.). *Adolescent Health*. <https://opa.hhs.gov/adolescent-health/physical-health-developing-adolescents/healthy-behavior>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- RE-AIM. (n.d.). *RE-AIM — Home — Reach Effectiveness Adoption Implementation Evaluation*. <https://re-aim.org/>
- Rey, O., Vallier, J.-M., Nicol, C., Mercier, C.-S., & Maïano, C. (2017). Effects of Combined Vigorous Interval Training Program and Diet on Body Composition, Physical Fitness, and Physical Self-Perceptions Among Obese Adolescent Boys and Girls. *Pediatric Exercise Science*, 29(1), 73-83. <https://doi.org/10.1123/pes.2016-0105>
- Society, C. P. (2003). Age limits and adolescents. *Paediatrics & child health*, 8(9), 577-578. <https://doi.org/10.1093/pch/8.9.577>
- Tu, A. W., Watts, A. W., Chanoine, J.-P., Panagiotopoulos, C., Geller, J., Brant, R., Barr, S. I., & Mâsse, L. (2017). Does parental and adolescent participation in an e-health lifestyle

- modification intervention improves weight outcomes? *BMC Public Health*, 17, 1-9.
<https://doi.org/10.1186/s12889-017-4220-0>
- Vidmar, A. P., Salvy, S. J., Pretlow, R., Mittelman, S. D., Wee, C. P., Fink, C., Steven Fox, D., & Raymond, J. K. (2019, Mar). An addiction-based mobile health weight loss intervention: protocol of a randomized controlled trial. *Contemp Clin Trials*, 78, 11-19.
<https://doi.org/10.1016/j.cct.2019.01.008>
- Wang, L. Y., Denniston, M., Lee, S., Galuska, D., & Lowry, R. (2010). Long-term Health and Economic Impact of Preventing and Reducing Overweight and Obesity in Adolescence. *Journal of Adolescent Health*, 46(5), 467-473.
<https://doi.org/10.1016/j.jadohealth.2009.11.204>
- Watts, A. W., Loth, K. A., Peterson, C., Boutelle, K. N., & Neumark-Sztainer, D. (2016). Characteristics of a Favorable Weight Status Change From Adolescence to Young Adulthood. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine*, 58(4), 403-409. <https://doi.org/10.1016/j.jadohealth.2015.09.009>
- WHO. (2014). *Obesity*. https://www.who.int/health-topics/obesity#tab=tab_1
- WHO. (2016). *Report of the commission on ending childhood obesity*.
<https://www.who.int/publications/i/item/9789241510066>
- WHO. (n.d.). *Adolescent Health*. https://www.who.int/health-topics/adolescent-health#tab=tab_1
- Wile Schwarz, S. P., Jason. (2010). Adolescent Obesity in the United States. *National Center for Children in Poverty*. <https://www.nccp.org/publication/adolescent-obesity-in-the-united-states-facts-for-policymakers/>
- Wilson, D. K., Sweeney, A. M., Quattlebaum, M., Loncar, H., Kipp, C., & Brown, A. (2021). The Moderating Effects of the Families Improving Together (FIT) for Weight Loss Intervention and Parenting Factors on Family Mealtime in Overweight and Obese African American Adolescents. *Nutrients*, 13(6), 1745-1745.
<https://doi.org/10.3390/nu13061745>

Appendix A: Literature Database Search Strategies

Adolescence

Adolescent* OR adolescence OR teen* OR tween* OR preteen* OR pre-teen OR “young adult” OR “young adults” OR “high school” OR “middle school” OR “junior high” OR “high school” OR youth* OR juvenile* OR puberty OR prepubescent

AND

Obesity

Obese* OR obesity OR overweight OR “excessive weight” OR “excessive fat” OR “excessive adiposity” OR adipose* OR fat*

AND

Weight Loss

“Weight Loss” OR “Body weight” OR “Body Weight Changes” OR “Body mass index” OR “Body size” OR “Waist circumference” OR “Skinfold thickness” OR Anthropometry OR “Body fat composition” OR “body composition” OR “waist-hip ratio”

AND

Secondary prevention

“secondary prevention” OR prevention OR “disease management” OR “treatment outcome” OR “obesity prevention”

AND

Controlled trial

"Randomized controlled trials" OR "evaluation studies" OR “feasibility studies” OR “intervention studies” OR “clinical trial”

Appendix B: RE-AIM Indicators and Definitions

| REACH | |
|--|---|
| Method to identify target population | Describe the process by which the target population was identified for participation in the study. Example: All patients who were part of the target population were identified using the electronic medical record. |
| Demographic & behavioral information | Gender, age, educational attainment, occupation, SES, behavioral outcomes. |
| Recruitment Strategies | Describe the methods used to recruit participants into the study. Example: We used a series of flyers; presentations; mass media; and word of mouth strategies to recruit participants. |
| Inclusion criteria | Explicit statement of characteristics of the target population that were used to determine if a potential participant is eligible to participate. Example: The inclusion criteria are... |
| Exclusion criteria | Explicit statement of characteristics that would prevent a potential participant from being eligible to participate. Also, the percent excluded may be reported. Example: The exclusion criteria are... |
| # Eligible and invited(exposed) to recruitment | The total number of eligible participants contacted for participation. Example: 300 people were contacted for the study. After a screener was administered, it was found that of those 300 people contacted, 250 people were eligible. Therefore 250 is the denominator. |
| Sample size | The number of people who agree to participate (e.g., n=) |
| Participation rate | Sample size divided by the target population denominator. Example: $200 \text{ (number of people agree to participate)} / 250 \text{ (number of eligible participants contacted for participation)} = 80\%$ |
| Cost of recruitment | The cost of recruitment can reflect monetary and/or time units. Example: The overall cost of recruitment strategy A (flyers) was \$1000 versus the overall cost of recruitment strategy B (newspaper advertisements) was \$200. Could also be coded in cost per participant recruited. |
| EFFICACY/EFFECTIVENESS | |

| | |
|--|--|
| Weight Change | Weight loss in kg or percent body weight loss or change in BMI |
| Quality of life measure | Includes a measure of quality of life with some latitude for coding articles that refer to well-being or satisfaction with life. |
| Measure unintended consequences (negative) and results | To evaluate unanticipated consequences and results that may be a product of the intervention and may have caused unintended harm. Example: In a PA promotion program, female participants had an increased rate of injury. |
| Percent attrition (at program completion) | The proportion that was lost to follow-up or dropped out of the intervention. This is calculated by dividing the number of participants who did not complete the intervention by the number of participants who began the intervention. Example: 100 participants began the intervention and 20 participants did not complete the intervention, so there was 20% attrition. |
| Cost effectiveness | Code as reported if specific mention and amounts are provided for the cost of the intervention. Example: The new strategy would save \$1,000 per life per year when compared to the current practice. |
| Use of qualitative methods to measure efficacy/effectiveness | Obtaining qualitative feedback from participants on the degree to which they felt the intervention was efficacious/effective. Some common methods include focus groups, interviews, diaries (text/pictures). |
| ADOPTION - SETTING LEVEL | |
| # eligible and invited(exposed) | Total sites that met eligibility criteria and were approached for intervention delivery. |
| # Participating | The total number of sites that agreed to participate. |
| Participation rate | The proportion of sites eligible and contacted that participated. |
| Description of targeted location | Characteristics that would be considered an ideal location for the intervention. |
| Inclusion/exclusion criteria of setting | The explicit statement of characteristics of the setting that were used to determine if a potential setting is eligible to participate. Example: The inclusion/exclusion criteria are... |

| | |
|--|--|
| Description of intervention location | The explicit statement of characteristics of the location of the intervention. Example: size of location; resources available staff information; number of eligible locations; work environment/climate |
| Method to identify setting | Describe the process by which the location was identified for participation in the study. |
| # of Comparisons | Total number and type of comparisons of targeted intervention sites and those that participated, including a list: size, location, etc. |
| Average # of persons served per setting | Calculated average number of participants at each site. |
| ADOPTION - STAFF LEVEL | |
| # eligible and invited(exposed) | Total staff that met eligibility criteria and were approached for intervention delivery. |
| # Participating in delivery | The total staff members that agreed to participate. |
| Participation rate | The proportion of the staff that was eligible and contacted and participated. |
| Level of expertise of delivery agent | Training or educational background in relevant area; Degrees, certifications of delivery agents (such as PhD, Masters, Registered Dietitian, etc.) |
| Measures of cost of adoption | The price of adoption across all levels of the intervention. At least some mention of start-up (i.e., not ongoing) costs. |
| Use of qualitative methods to measure adoption | Used qualitative methods to understand the process of adoption. Example: focus groups, interviews of adoption settings or delivery agents |
| IMPLEMENTATION | |
| Guided by theory | Statement of theories or principles used to guide intervention |
| Intervention number of contacts | Total number of encounters with participants. Could include face-to-face meetings, telephone calls, newsletters etc. |

| | |
|--|--|
| Timing of contacts | Describe when the intervention contacts occur over the course of the intervention. Example: For the first month participants received one telephone call per week and in every month thereafter they received a call a month until the end of the 12-month intervention |
| Duration of contacts | Length of each intervention contact. Example: The first 4 calls lasted about 20 minutes each, the other 11 lasted about 10 minutes each. |
| Extent protocol delivered as intended (%) | Description of fidelity to the intervention protocol. Example: checklist of program components assessed by delivery agent(s) |
| Consistency of implementation across setting and delivery agents | Description of the degree of similarities between multiple settings sites & delivery agents |
| Participant attendance/completion rates | The proportion of the intervention that the participants received, on average. Example: Participants attended 4 of the 6 meetings on average. |
| Measure of cost | The ongoing cost of delivery across all levels of the intervention |
| Use of qualitative methods to measure implementation | Used qualitative methods to understand the process of implementation. Example: focus groups, interviews |
| MAINTENANCE | |
| Was individual behavior assessed at some duration following the completion of the intervention? (Give duration of follow-up) | Description of follow-up outcome measures of individuals available at some duration after intervention termination Example: 6 months after the intervention ended participants had returned to baseline levels of PA. |
| Attrition | Describe the degree to which participants were lost to follow-up (and the reasons) during the period from the interventions completion to the follow-up. |
| Use of qualitative methods to measure individual maintenance | Used qualitative methods to understand the process of individual level maintenance of changes to the primary outcome. Example: focus groups, interviews |
| Was the program institutionalized? | Description of the how the intervention was integrated into the delivery system through methods such as policy changes, job description changes. |

