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Review article

Family-based lifestyle interventions: What makes them successful? A systematic literature review

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ABSTRACT

Nearly one in five young people in the United States has obesity, putting one-fifth of America's children at higher risk of having chronic health conditions and of having obesity into adulthood. Family-based lifestyle interventions (FBLI) have been proposed as effective mechanisms to improve the health through health education and the adoption of healthier behaviors. The aim of this review is to identify and summarize effective intervention activities and lessons learned that organizations can adopt when planning health promotion interventions for families, and to assess the effect of family-based lifestyle interventions on BMI z-score. A systematic review on lifestyle health-promotion interventions for families was conducted following PRISMA (Preferred Reporting Items for Systematic reviews and Meta-analyses) statements. Inclusion criteria were: duration ≥12 weeks and inclusion of family members. Summary data about the assessment tools, intervention strategies, and outcomes in parents and children were extracted and compared for all studies. A meta-analysis of BMI z-score change was conducted. Thirty-four articles were included in this review. Frequent strategies used were delivering education and training on healthy habits and well-being (94%), engaging community in the planning and implementation phases (80.6%) and providing reminders and feedback (47.2%). BMI z-score mean differences were reported in 40 cohorts and included in a meta-analysis, with no statistically significant differences between groups. The findings of this systematic review and meta-analysis indicate that components of a successful family lifestyle intervention program include duration between six to twelve months and delivery in a community setting. Other key factors include constructing a multidisciplinary team, using a mentor/role model approach, and reinforcing messaging with technology.

1. Background

Nearly one in five school age children and young people in the United States has obesity, putting one-fifth of America's children at higher risk of having chronic health conditions, having lower self-esteem and of having obesity into adulthood. Community-based lifestyle interventions (CBLI) have been proposed as effective mechanisms to improve the health of local communities through health education and the adoption of healthier behaviors (Wang et al., 2016). CBLIs take on a population approach attempting to reduce risk factors for or causes of diseases within communities. Communities can be defined in terms of localities, or can represent groups who share a common cause or interest (Satterfield et al., 2003). This community approach rests on the premise that the intervention respects community strengths, is dictated by cultural practices, and depends on meaningful community participation (Satterfield et al., 2003; Viswanathan, 2004; Wallerstein and Duran, 2010).

The Academy of Nutrition and Dietetics recognizes that obesity is a significant problem for children in the United States and has taken the position that family and school-based interventions are required to approach this problem that is currently adding billions of dollars to US healthcare spending. The Academy of Nutrition and Dietetics found that there are two specific kinds of overweight interventions that yielded positive effects: multicomponent, family-based programs for children between the ages of five and 12 years, and multicomponent, school-based programs for adolescents. The Academy of Nutrition and Dietetics also emphasizes the need for continued work to develop and study intervention for particular subsets of the population, including

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those of varying ethnicities (American Dietetic, 2006). Higher rates of childhood obesity are seen in non-Hispanic black and Hispanic youth, in lower income groups, and in households with lower head of household education level, compounding the urgency to study these populations (Cawley and Meyerhoefer, 2012).

Research has shown that health habits and weight during childhood were associated with health habits and health outcomes during adulthood (Arredondo, 2006; Golan and Crow, 2004; Ransdell et al., 2003; Ventura and Birch, 2008). The family has a powerful influence over the development and maintenance of children's eating, exercise, and entertainment habits. The strong influence of the relationship between the parent or caregiver and child, including modeling of health behaviors, creating an environment conducive to active or sedentary lifestyles, choosing and preparing food, and encouraging and reinforcing eating and physical activity patterns, suggests that parents and caregivers must be involved in interventions designed to increase healthy eating and physical activity in childhood (Eisenmann, 2008; Epstein et al., 1994).

To our knowledge, there has not been a systematic review study summarizing best practices regarding the design, implementation, and sustainability of family-based lifestyle interventions (FBLI) to guide program planners and community members in building successful interventions that promote healthy nutrition and physical activity habits. As part of our effort to develop a CBFLI in a low-income suburban predominantly African American community in a major U.S. city, we conducted a systematic review of health promotion interventions for families in different settings to identify key aspects of existing programs that were important for the success of our intervention.

The overall objective of this review is to identify and summarize effective intervention activities and lessons learned that organizations can adopt when planning lifestyle health promotion intervention for families. We will focus on the effect of the family-based interventions on lifestyle behavioral change with BMI or BMI z-score as main outcome measure in children or adolescents.

2. Methods

The protocol for this systematic review and *meta*-analysis was based on the PRISMA-P (Preferred Reporting Items for Systematic reviews and Meta-analyses) (Moher, 2015). The review was executed according to the Cochrane Handbook for systematic reviews of interventions following the PRISMA statement (Moher, et al., 2009; Higgins and G.S.e, 2011). Protocol was approved by the PROSPERO register; the registration number is CRD42020149948 (2/14/2020).

2.1. Literature search strategy

A comprehensive systematic review on lifestyle health-promotion interventions for families in different settings was performed in PubMed, Medline and Scopus databases. The following query was used: (dyad[mesh terms] OR family[mesh terms]) AND (community center [mesh terms] OR church[mesh terms] OR school[mesh terms]) AND (behavioral intervention[mesh terms] OR physical activity[mesh terms] OR nutrition[mesh terms] OR weight[mesh terms] OR lifestyle[mesh terms]). Studies included were published between January of 2006 and May of 2018. The systematic review search was conducted in June 2018.

2.2. Study selection

Eligible studies included randomized control trials (RTCSs), non-RTCs and case control studies, with focus on lifestyle changing interventions. Lifestyle changing interventions were any form of dietary, physical activity and/or behavioral therapy delivered as single or multicomponent interventions. Additionally, articles were eligible if: a) there was family involvement (child(ren) and parent(s)); b) subjects were healthy adults/children with or without overweight/obesity; c) outcome measures included body mass index (BMI or BMI z-score), behavioral change or weight; and d) intervention duration was $\geq$ 12 weeks. Articles were excluded if: e) interventions did not reported outcome measure as BMI or BMI z-score, f) interventions focused solely on the parents or children; g) participants were pregnant women, critically ill, or had a secondary or syndromic cause of obesity; or h) interventions dealt specifically with the treatment of type II diabetes or eating disorders.

Three reviewers (A.A., N.L. and N.LM.) autonomously screened the titles and abstracts to determine the studies that met the inclusion criteria. In case of discrepancy a third reviewer screened the abstract (N. M.). In the second phase two reviewers (A.A, N.L.) independently read the complete articles. If a discrepancy occurred, the third reviewer read the article and discrepancy was resolved upon discussion and consensus was reached between the two reviewers.

2.3. Data extraction

Data were extracted independently by three reviewers (A.A, N.L. and N.M.). Guidelines for abstracting data were established by the study team to assure optimal data extraction. A database template was created in REDCap 8.3.0 - © 2019 Vanderbilt University platform, for data extraction consistency. Any disagreements or contradictions in abstracted data were resolved by re-review of the article by the reviewers to come to a consensus. Extracted data from the articles included: a) first author, publication year, study location; b) study design, intervention conceptual framework, target population, intervention characteristics; c) participants age, ethnicity; d) outcome measures, BMI (BMI z-score); and d) study results.

2.4. Quality assessment

Three reviewers were responsible for assessing quality according to the Downs and Black quality checklist for health care interventions (A.A, N.L. and N.M.). Studies were classified based on total of points out of 27 (Downs and Black, 1998). Differences in appraisals were resolved by reaching consensus.

2.5. Synthesis of results

Summary data about the assessment tools, intervention strategies, primary and secondary outcomes in parents and children were extracted and compared for all studies that were identified. Studies reporting BMI z-score were included in a *meta*-analysis as primary outcome, assessing the overall effect size of the intervention. In cases in which different groups were studied and reported outcomes we separate them and designate as separate groups for our analysis, naming them "cohorts". Cohorts were selected from each unique intervention and compared to the respective control group within each study. Statistical analyses for the *meta*-analysis were performed using Stata version 12.0 (STATA Corp. College Station, Texas). Outcomes were analyzed on an intention to treat bias using random-effects models. We estimated the association between a family-based lifestyle intervention and the primary outcome (BMI z-score in children/adolescents) by calculating mean difference in BMI z-scores between baseline and follow-up with 95% confidence intervals (95% CI) for each study. In addition, a stratified analysis and meta regression analysis was performed utilizing the following covariates setting, population age, and length of intervention. Setting was described according to place of intervention delivery in three groups: school, health care facility (i.e. clinic) and community (i.e. park district, gym). Population age was categorized in three groups: zero to five years, six to 12 years and 13 to 18 years old. The length of intervention was categorized in 3 groups: 12 weeks to six months, six to 12 months, and $>$ 12 month.

Publication bias was assessed with rank correlation test proposed by Begg and Mazumdar and the regression test proposed by Egger.

3. Results

3.1. Description of studies selected

The search strategy identified 549 titles, of which 72 articles were selected for further review. During further review, 48 additional titles were identified through references. Of these 120 articles, thirty-four met the inclusion criteria and reported BMI z-score as a primary outcome. These articles constituted the analytic sample. Studies without primary outcome were excluded.

Body mass index (BMI) z-scores for children were reported in 34 studies and included 40 cohorts, which were included in the *meta*-analysis (Fig. 1). Supplemental Table 1 includes descriptive characteristics of studies included in analysis.

Forty-seven percent (19 out of 40) of the cohorts were part of interventions based in schools, the remainder of the studied cohorts took place in health care settings (12 interventions) or community (9 interventions). Interventions deployed a variety of strategies, the two most common being delivering education and training, and restructuring the care team. The least common strategies were using technology and providing financial incentives. The target population varied by intervention, 20 cohorts were comprised of 6–12 year old's, 10 were 13–18 year old's, and 10 were 0–5 year old's. Fifteen of the interventions (38%) had durations $>$ 12 months, 13 (32%) between six and 12 months, and 12 (30%) $<$ six months (Fig. 2; Supplemental Table 1).

3.2. Meta-analysis of BMI z-score mean change

After conducting a *meta*-analysis of the 40 cohorts under the random effect model, the overall effect size of BMI z-score mean change was −0.14 (−0.26, −0.08). The between study differences were not explicable by random variation; there was a high between study heterogeneity attributable to variability in the true treatment effect (96.3%), rather than sampling variation. Thus, we rejected the null hypothesis. Under the fixed effect model the effect size is very similar. The forest plot is displayed in Fig. 3.

The possibility of treatment effect variation by subgroups (i.e. population age, setting and length of intervention) was assessed. When stratifying by setting, interventions delivered in schools have a stronger effect than those delivered in clinics. However, with interventions delivered in community settings, there is more consistency of positive effect across studies reaching statistical significance test of SMD ($p = 0.04$) (Fig. 4; Appendix 3, Fig. 1). When stratifying by population age group, children between six and 12 years old have a stronger effect size than adolescents ($p = 0.024$) or infants (Fig. 5; Appendix 3, Fig. 2). When stratifying by length of intervention, intervention delivery length between six and 12 months denotes stronger effects over BMI z-score mean change compared with those interventions with $<$ six months of duration and $>$ 12 months of duration (p 0.05) (Fig. 6; Appendix 3, Fig. 3).

A *meta*-regression analysis was conducted, including the covariates intervention setting, length of intervention and population age; the residual variation due to heterogeneity was 95.85%, with 3.4% attributable to between-study sampling variability being smaller than expected if it was due to chance alone. The joint p value was not significant, with none of the covariates being statistically significantly associated with the effect size. The normal probability plot suggests that the assumption of normal random effects is adequate. There are 3 notable outliers noting that the largest standardized shrunken residual is −3.5. After dropping the 3 outliers from the analysis, the normal probability plot did not improve so they were not taken out of the analysis (Appendix 2: Figs. 1 and 2).

The presence of bias was studied looking for small studies effect based on two sided p-values. Few studies were outside the funnel area

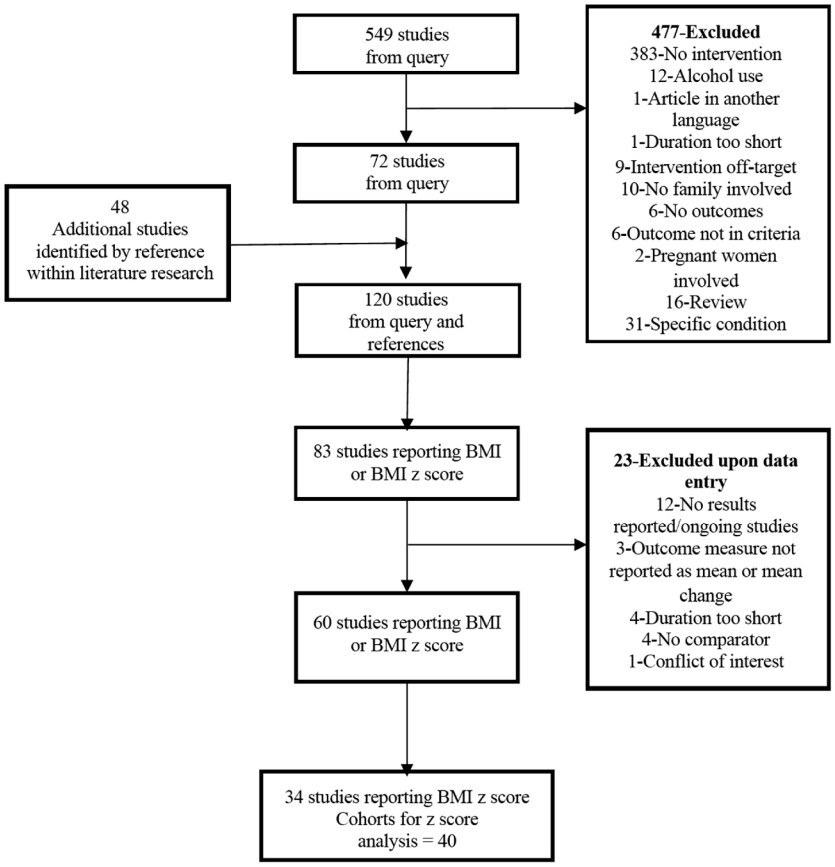

Fig. 1. Flowchart of the systematic review and *meta*-analysis according to the PRISMA guidelines.

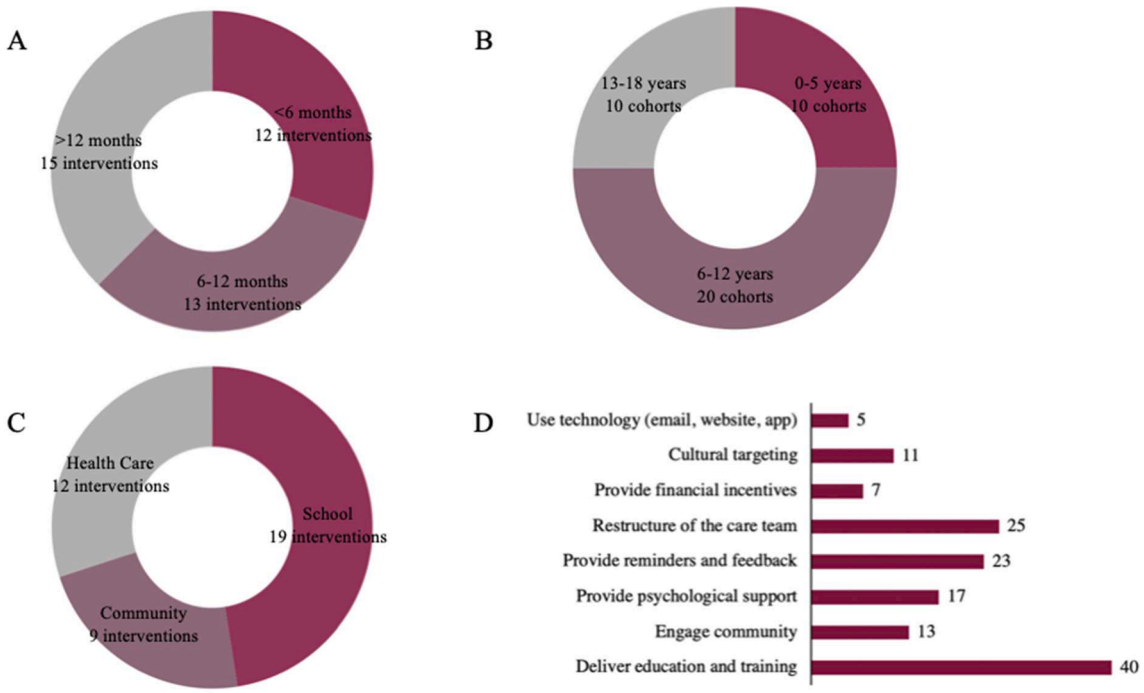

Fig. 2. Intervention setting characteristics varied across the studies. Panels A-C: Pie charts depict the intervention characteristics by number of interventions or cohorts. Panel D: There were common techniques used by different interventionalists, shown in this bar graph as the number of interventions that contained each component, with the most common being delivering education and training.

where studies are perceived missing is within the region of statistical significance. Under this assumption, it is more reasonable to consider publication bias as the potential cause of the funnel asymmetry (Appendix 2: Fig. 3).

The estimated bias coefficient by Egger's bias test is 0.015 ($>|t|=0.993$); this does not indicate the presence of asymmetry and publication bias. The sign of the coefficient (negative) suggests that small studies, negative and/or non-significant might not be included in the analysis. The slope of the coefficient −0.13 is slightly smaller than the effects estimated from *meta*-analysis of the data using the random effect model (theta = -0.14). These small differences in effect estimates are not consistent with those expected when small, negative studies are excluded.

Furthermore, when investigating bias stratifying by setting of intervention delivery, the studies out of the pseudo 95% CI are mostly from school settings. When stratifying by age group the outliers seem to be distributed evenly across groups. Finally, when stratifying by group of intervention time, the outliers belong to the intervention group delivered in < 6 months and > 12 months (Appendix 2: Figs. 4, 5 and 6).

3.3. Summary of successful interventions

We review the variables that can contribute to differences of outcomes, namely consistency of delivery, methods of reporting, intervention components and limitations of long-term follow-up, to determine which ones outstand in studies that reported statistically significant results for BMI z-score change.

Of the 15 interventions reporting statistical significance, eight were conducted in schools (Sosa et al., 2016; Johnston et al., 2007; Vilchis-Gil et al., 2016; Wright et al., 2013; Wengle, et al., 2011; Morgan et al., 2014; Amini et al., 2016; Bacardi-Gascon et al., 2012; Grydeland et al., 2014); five in healthcare settings (Janicke et al., 2008; Endevelt et al., 2014; Wengle, et al., 2011; DeBar et al., 2012; Pakpour et al., 2015), and two in the community (Morgan et al., 2011; Sacher, P.M., et al., Randomized controlled trial of the MEND program: a family-based community intervention for childhood obesity. Obesity (Silver Spring), 2010). The average length of intervention for statistically significant interventions was 6.4 months, and the follow up was 10.5 months. Also of note, the majority of these statistically significant interventions, 11 of the 15, were directed to 6–12 year olds (Janicke et al., 2008; Endevelt et al., 2014; Morgan et al., 2014, 2011; Johnston et al., 2007; Vilchis-Gil et al., 2016; Amini et al., 2016; Bacardi-Gascon et al., 2012; Sacher, P. M., et al., Randomized, 2010; Grydeland, 2013). When stratifying all BMI z score cohorts by population age group, it's shown under the random effect model that this age group has a stronger effect size than adolescents ($p = 0.024$).

Thus, showing the importance of identifying elements of individual interventions that seem to have made them successful, such that these elements can be tailored by future researchers hoping to improve lifestyle (i.e. nutrition and physical activity) in their own communities (Table 1). It appears that successful factors include delivering education and training, mentoring, include a multidisciplinary team approach, culturally adaptation, provision of psychological support/reminders and feedback, environmental systemic adaptation, and family involvement. Detailed description of the components of successful interventions is described in the discussion section.

4. Discussion

Family lifestyle interventions for health promotion may help to improve health outcomes. The high between study heterogeneity is to be expected in comparing lifestyle interventions like the ones included in this study. There are myriad variables that can contribute to differences of outcomes, namely consistency of delivery, methods of reporting, intervention components and limitations of long-term follow-up. Although conclusive evidence cannot be derived from these results, it is incredibly valuable to extract elements of particular interventions that made them successful. For the same reason that there were no strong associations along any of the large subgroups analyzed, the success of interventions is likely due to more nuanced factors understandable only at a community level. Additional summary of identified successful factors will be discussed below.

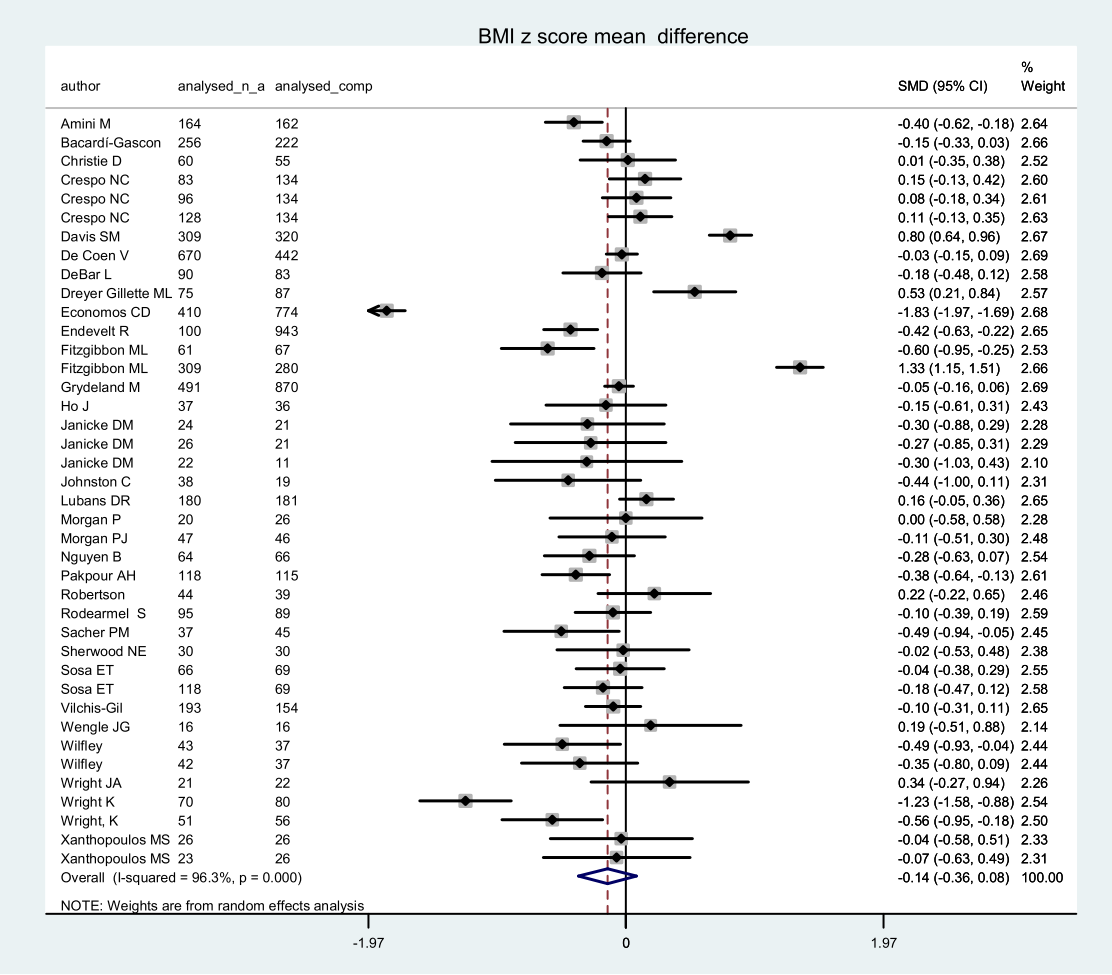

Fig. 3. Forest plot displaying a random-effects *meta*-analysis of the effect of family lifestyle intervention on BMI z-score change.

By studying interventions that reported statistically significant results for BMI z-score change, it appears that successful factors include delivering education and training, both towards intervention participants, but also through restructuring the care team to receive training in delivering the intervention. Namely (Janicke et al., 2008) provided two full days of training before the intervention, and one six hour booster midway through the intervention for two interventionists (Janicke et al., 2008).

Others, like (Endevelt et al., 2014) include a multidisciplinary team approach, including a dietitian, a physical therapist, a physical activity coach and a social worker. The lattermost being important in engagement and providing psychosocial counseling on parenting and lifestyle change sustainability (Endevelt et al., 2014).

The intervention, "Kids N Fitness" (Wright et al., 2013) focused on implementing a nurse directed school-based program, taking advantage of training and expertise that nursing professionals already have. This intervention was also successful in applying a Community Based Participatory Research (CBPR) framework and including a Community Advisory Board for researchers' feedback.

(Wengle, et al., 2011) used mentor support provided by university students to improve healthy lifestyle in adolescents (Wengle, et al., 2011). A role model approach was also used in the "Healthy Dads, Healthy Kids" program (Morgan et al., 2014, 2011), in which parents and children reinforce each other's behavior change.

Interventions targeted toward minority communities took extra steps to ensure the care team was structured appropriately for the target population. (Sosa et al., 2016) employed parent peer educators recruited through the Head Start Center Director. The parent educators attended training, studied scripts, and familiarized themselves with the health information materials developed by University Faculty. In addition to having the parent educators be peers of the parent subjects of the intervention, the *"Miranos"* intervention included bilingual and Spanish speaking educators to make sure the material was accessible and culturally sensitive (Sosa et al., 2016).

Another example of mentoring is in the (DeBar et al., 2012) intervention, in which teachers and parents served as secondary supporters for adolescent girls. This was based on reasoning that adolescents are more autonomous than younger children, so may be less motivated by parental influence. Here, participants' primary care providers were trained to support behavioral weight management goals in a collaborative way. This approach of involving adults that aren't necessarily parents might be an effective tactic for delivering interventions to older youth (DeBar et al., 2012).

Another common theme that emerged was that successful interventions consistently reported the provision of psychological support/reminders and feedback (Janicke et al., 2008; Johnston et al., 2007). For example, (Johnston et al., 2007) implemented a token economy system to reinforce participant behavior changes—points for achieving milestones could be exchanged for prizes. (Johnston et al., 2007) comments that this provision of frequent feedback to model and reward children in their efforts might be required for initial efforts at achieving healthy weight status.

Others used websites for program delivery supplemented by text messages to motivate and reinforce behavior changes (Vilchis-Gil et al.,

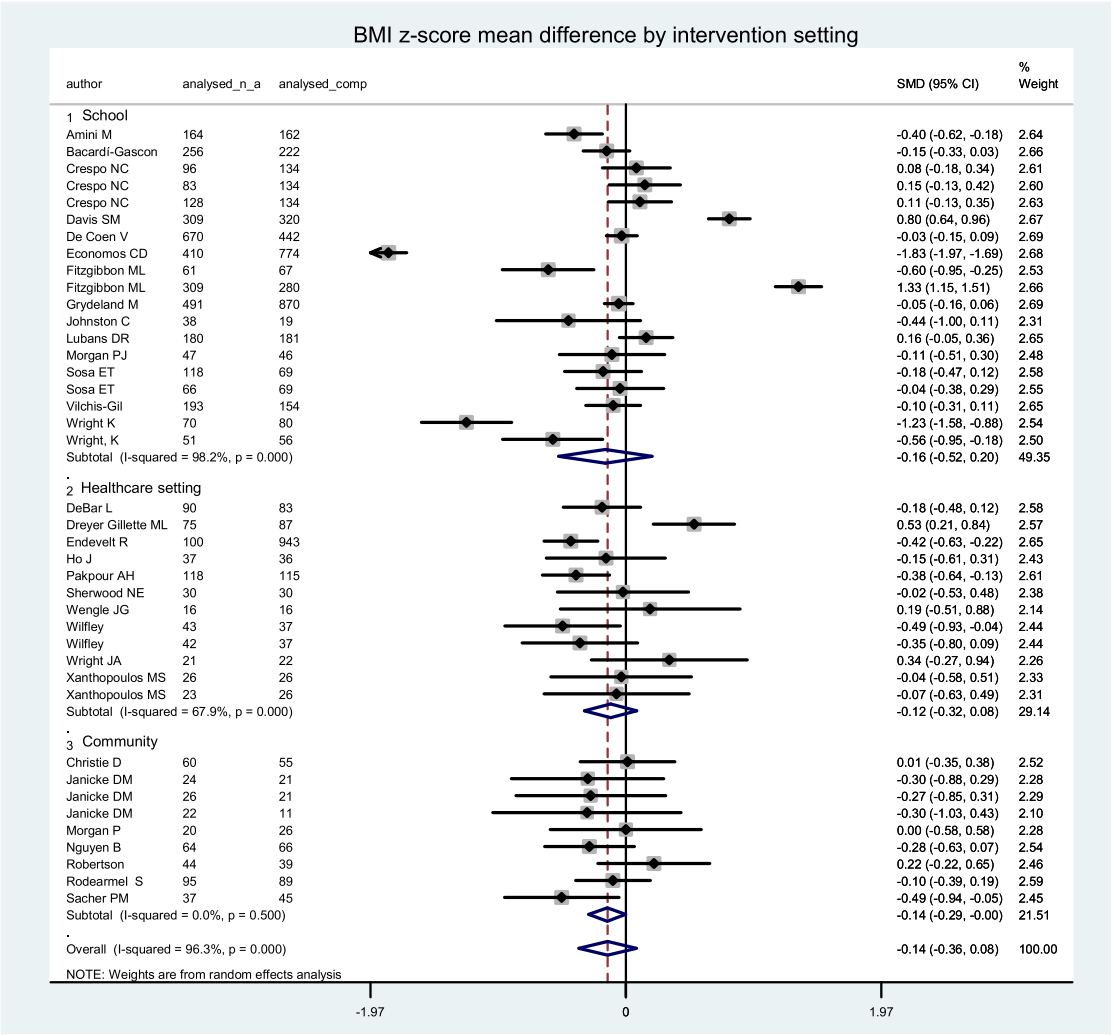

Fig. 4. Forest plot displaying a random-effects *meta*-analysis of the effect of family lifestyle intervention on BMI z-score change. Results are stratified by delivery of intervention setting subgroup.

2016). In the school centered intervention by (Vilchis-Gil et al., 2016), text messages were sent to parents to direct them to the updated website and to reinforce the information provided. This emphasized that parents are key players in promoting healthy habits within the family.

The (Pakpour et al., 2015) study used motivational interviewing to target improved eating and physical behavior in obese Iranian adolescents. Their results found that motivational interviewing of both the child and the parent was superior to motivational interviewing with the child alone (Pakpour et al., 2015).

The differences in conclusions found by the different studies (i.e. (Sosa et al., 2016); (DeBar et al., 2012) , and (Pakpour et al., 2015) illustrate the importance of interpreting results of community based interventions in a cultural and sociodemographic context. As alluded to previously, what is successful in one community may not be in another, and this is especially true when crossing geographic—but also cultural and sociodemographic—lines.

Of the 15 interventions reporting statistical significance, eight were conducted in schools (Sosa et al., 2016; Johnston et al., 2007; Vilchis-Gil et al., 2016; Wright et al., 2013; Wengle, et al., 2011; Morgan et al., 2014; Amini et al., 2016; Bacardi-Gascon et al., 2012; Grydeland et al., 2014); five in healthcare settings (Janicke et al., 2008; Endevelt et al., 2014; Wengle, et al., 2011; DeBar et al., 2012; Pakpour et al., 2015), and two in the community (Morgan et al., 2011; Sacher, P.M., et al., Randomized, 2010). School wide interventions took advantage of the ability to make environmental changes that would most likely potentiate change based on material provided in educational sessions to students and/or parents. In the HEIA study presented by (Grydeland et al., 2014), intervention schools received an “Activity Box” with sports equipment and a resource box for school management, that allowed for change to school environments both in and outside of the classroom. There was a strong focus on having teachers as central components to the intervention delivery, paralleling the objectives centered on making changes in the classroom, and having children undertake behavioral changes alongside their classmates (Grydeland et al., 2014; Grydeland, 2013).

In an even broader school environmental systemic change, Bacardí et al. (2012) reported an approach involving improving school meals/snacks, improving physical activity installations on the school grounds, and offering physical activity opportunities during or after school. This approach takes advantage of the many week hours a child spends at school (Bacardi-Gascon et al., 2012).

The average length of intervention for statistically significant interventions was 6.4 months, and the follow up was 10.5 months. Also of note, the majority of these statistically significant interventions, 11 of the 15, were directed to 6–12 year olds (Janicke et al., 2008; Endevelt et al., 2014; Morgan et al., 2014, 2011; Johnston et al., 2007; Vilchis-Gil et al., 2016; Amini et al., 2016; Bacardi-Gascon et al., 2012; Sacher, 2010; Grydeland, 2013). As previously discussed, the Academy of Nutrition and Dietetics recommends multicomponent, family-based

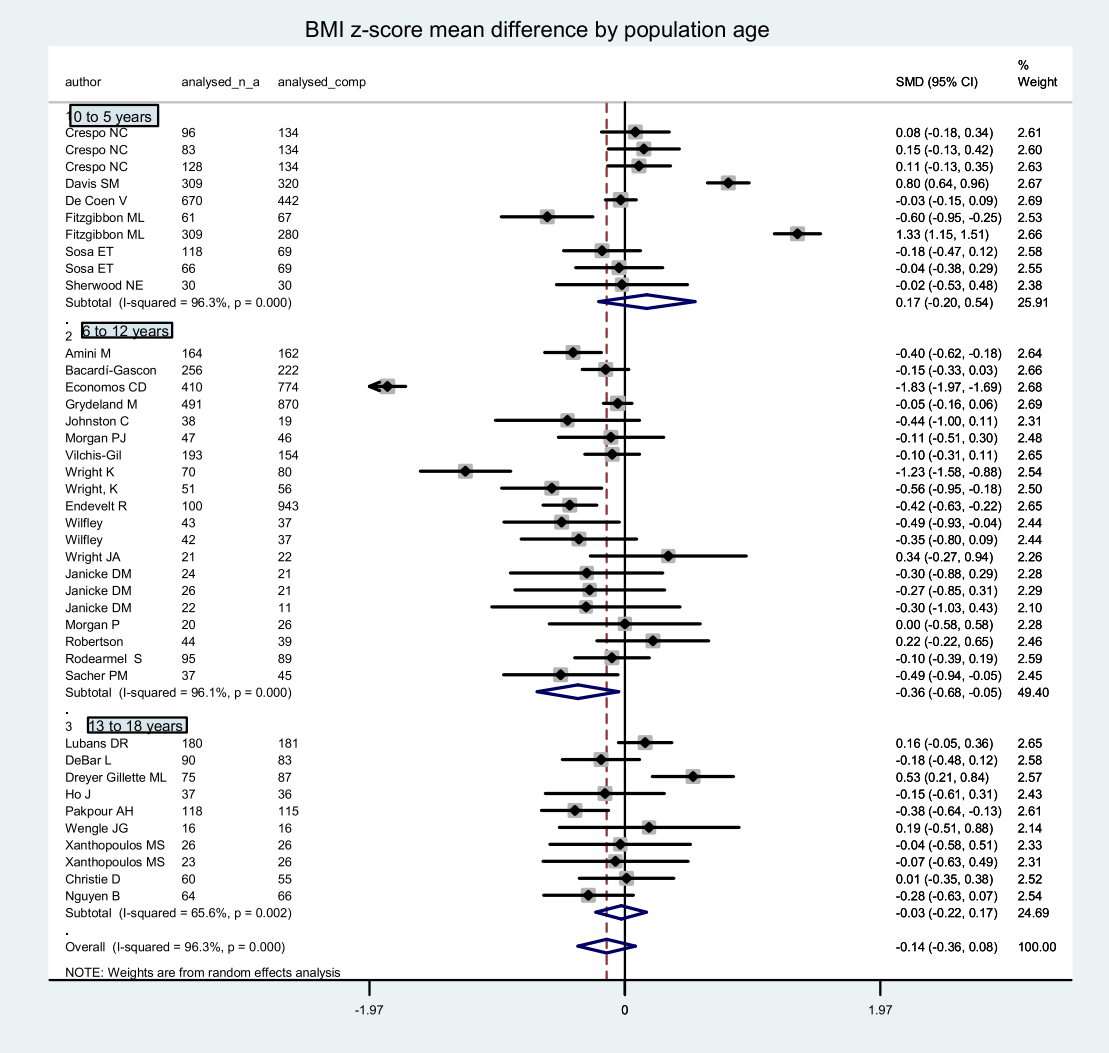

Fig. 5. Forest plot displaying a random-effects *meta*-analysis of the effect of family lifestyle intervention on BMI z-score change. Results are stratified by population age subgroup.

programs for children of these ages (American Dietetic, 2006). Family involvement was central to many successful interventions targeting this age range. Interventions in schools were accompanied by parental involvement through parent education groups (Morgan et al., 2011; Johnston et al., 2007); parent support groups to discuss challenges and successes (Wright et al., 2013); parent newsletters (Wright et al., 2013) and text messages sent to parents to reinforce behavior change topics (Vilchis-Gil et al., 2016). In the successful interventions targeting 13–18 year old's, greater emphasis was placed on the autonomy of the adolescent, through peer group meetings (DeBar et al., 2012) and involvement of other mentors in the adolescents' lives, for example, university students (Wengle, et al., 2011) and paediatricians (DeBar et al., 2012).

Overall, successful factors were interventions that used more than one method to promote change behavior, for example clinics with the involvement of parental education, follow up phone calls, website/newsletter material prove to be successful among school age children. Other interventions, particularly community based, in which more than one element was targeted (i.e. environmental infrastructure, policy change, and community workers) derived more impacts as a whole for all age groups. BMI z-score change is not easily achieved with only one intervention, so more emphasis should be placed on interventions that involve environmental and structural changes at multiple levels—policy, community, and family.

An important aspect of all these interventions is that the long-term sustainability of weight/BMI change remains unknown. Studying behavior change and long-term outcomes in children and adolescents is challenging due to the multifactorial nature of a child's weight and their lifestyle. Finding appropriate measures to reliably track a child's behaviors overtime and the impact of these behaviors on long term health must be pursued.

In our review, the majority of studies targeted children ages six-12, however, a recent retrospective analysis done in Germany by (Geserick et al., 2018) found that among obese adolescents, the most rapid weight gain had occurred between two and six years of age. The study concluded that most children who were obese between these ages were obese in adolescence (Geserick et al., 2018). This study reinforces the obesity projection study by Ward, et al findings were 60 percent of today's two-year-old's, if projections hold, will be clinically obese by the time they turn 35 years old (Ward et al., 2017).

This points to the importance of early interventions; in our review, only 11 interventions target this age group. This emphasizes the need for future interventions in even the youngest of populations. Lifestyle interventions can have powerful impact on health across demographics, but as stated by our study objective, they have particular importance for children.

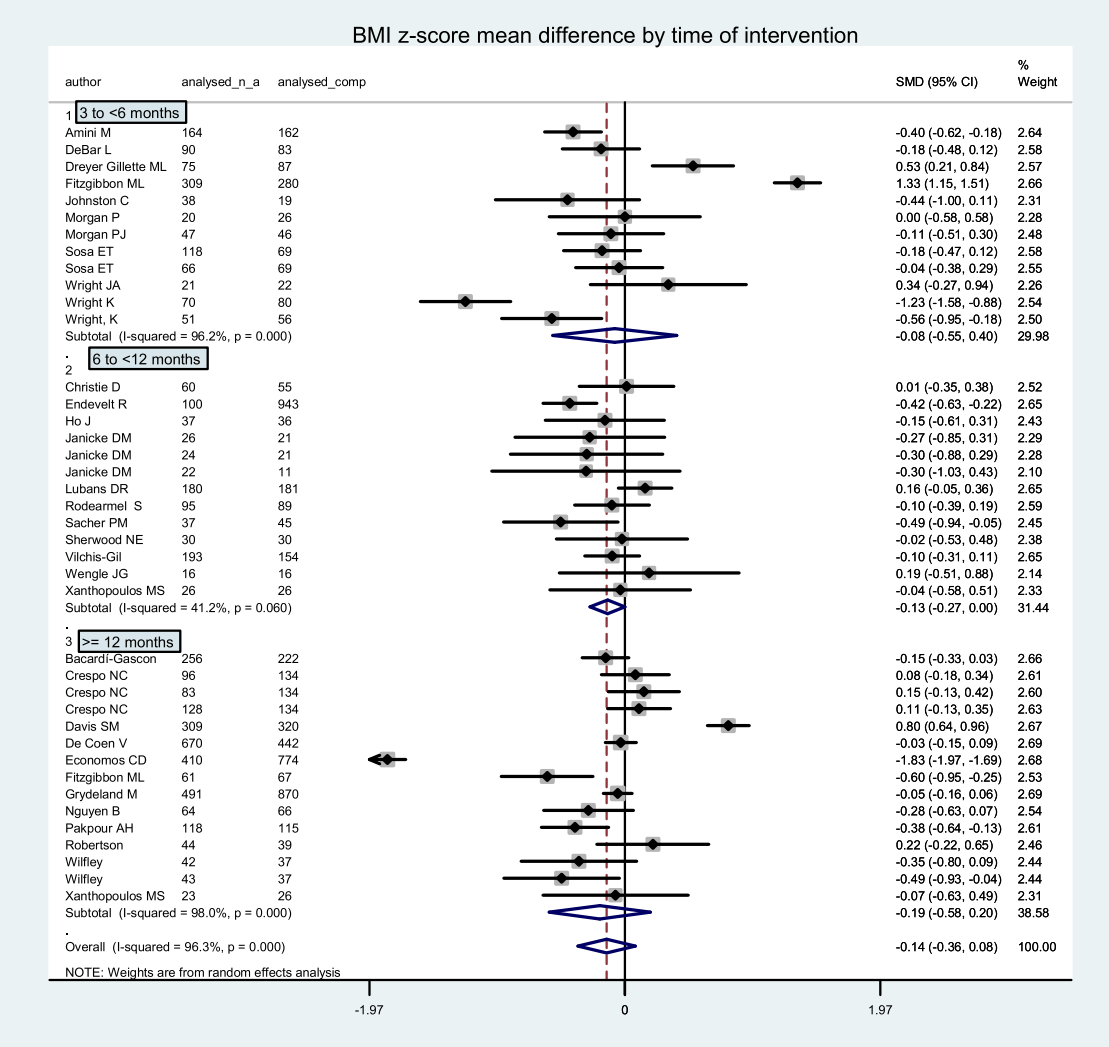

Fig. 6. Forest plot displaying a random-effects *meta*-analysis of the effect of family lifestyle intervention on BMI z-score change. Results are stratified by population intervention time group. (3 to < 6 months, 6 to < 12 months, 12 ≥ months).

Behavioral change interventions targeting healthy lifestyles are numerous. The need for studies that address questions on how to keep attrition low, adapt intervention to different communities and cultures, in addition to strategies on how to keep participants motivated and engaged in family-based lifestyle programs to achieve healthier lifestyles long term will be important to be successful. In addition, engaging community stakeholders, policy makers and academics in partnerships will have a wider impact at a population level to make changes sustainable.

4.1. Limitations

Where RCTs were available, biases due to improper allocation concealment and attrition are relevant. Blinding of participants is difficult, however, particularly in educational interventions. Other sources of bias include the potential for the control/comparison group to become 'contaminated' (e.g., within schools where participants in the intervention and control groups are highly likely to come into contact with each other).

5. Conclusions

In our review of the literature to identify key factors driving successful family-based lifestyle interventions, the results suggest that programs with duration between six to 12 months were more successful in achieving behavior change (i.e., around nutrition and physical activity), knowledge of good habits, and adherence to the intervention than those of longer duration (≥12 months).

Additionally, programs delivered in community settings (over school setting or clinics) that encouraged active engagement of community leaders and supported whole-family participation in the intervention with an appropriately-tailored intervention programing for each family member, reported successful outcomes. Our review also identified that factors that improve behavioral change outcomes include building a multidisciplinary team, using mentor/role model approach and reinforcing education messages with technology (web, text, phone, face-to face).

Despite the presence of these factors, programs on average did not achieve significant changes in BMI z score. In order to achieve a change in BMI z score, ongoing programs are needed, along with participants' continued engagement. Studies are needed to address the question of how to keep participants motivated and engaged in family-based lifestyle programs to achieve healthier lifestyles long term, and how to engage community stakeholders to have a wider impact at a population level to make changes sustainable.

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CRediT authorship contribution statement

Anne Arnason: Data curation, Methodology, Writing - original draft **Nayeli Langarica:** Data curation, Writing - review & editing. **Lara R. Dugas:** Writing - review & editing. **Nallely Mora:** Data curation, Formal analysis, Methodology, Writing - original draft. **Amy Luke:** Funding acquisition, Writing - review & editing. **Talar Markossian:** Conceptualization, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2020.101299.

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