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Review

Parent participation in weight-related health interventions for children and adolescents: A systematic review and meta-analysis

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ABSTRACT

Objective. To review child and adolescent weight-related health intervention characteristics, with a particular focus on levels of parental participation, and examine differences in intervention effectiveness.

Methods. Multiple social science, health, and medical databases were searched, and experimental randomized controlled studies of child and adolescent weight-related health interventions, reported in January 2004 through December 2010, were collected. Intervention characteristics were reviewed, and pre- and post-measurement data, including body mass index, were extracted for analyses. Differences in effect sizes of experimental and control groups were used to evaluate effectiveness of interventions.

Results. Reports of 42 interventions were included. Intervention activities consisted of nutrition education, physical activity education, physical activity sessions, behavior education, behavior therapy, or a combination of these activities. Significant differences existed among levels of parent participation, $p<0.05$. In addition, intervention duration positively predicted intervention effectiveness, $p=0.006$, and the linear combination of parent participation and intervention duration significantly predicted intervention effectiveness, $p=0.001$.

Conclusions. This study suggests that weight-related health interventions that require parent participation more effectively reduce body mass indexes of child and adolescent participants. In addition, longer interventions that include parent participation appear to have greater success. Suggestions for future research and related interventions are provided.

Contents

Abbreviation: WRH, Weight-related health.

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Introduction

Diet and weight of both youth and adults in the American population are a national concern, and overweight conditions among children and adolescents have become a growing focus of public health (United States Department of Health and Human Services [USDHHS], 2010). According to results from the National Health and Nutrition Examination Survey (NHANES), the prevalence of overweight conditions among children and adolescents has had an increasing trend since the mid-1970s (USDHHS, 2006). In the U.S., more than 10% of children aged 2 to 5 years, 19.6% of children aged 6 to 11 years, and 14.5% of adolescents aged 12 to 19 years are overweight or obese (Ogden et al., 2010).

Overweight conditions in childhood are associated with increased risk for chronic diseases (Freedman et al., 2008; Murthy et al., 2009; Rees et al., 2009; Signorino and Winter, 2008; Wang et al., 2011b; Weintrob et al., 2008) and other health concerns (Lobstein et al., 2004; Yancey and Kumanyika, 2007). Lobstein et al. suggest that multiple organ systems are negatively affected by excessive bodyweight in children, and almost all organ systems are negatively affected by obesity. Related health conditions include Type II diabetes, breathing disorders, fatty liver disease, and cardiovascular disease symptoms (Lobstein et al.). In addition, overweight children and adolescents experience reduced physical abilities, mental health problems, and related social consequences (Lobstein et al.).

Juvenile overweight conditions usually persist into adulthood, and the aforementioned consequences follow or worsen (Heath and Panaretto, 2005; Serdula et al., 1993; Yancey and Kumanyika, 2007). Individual and societal costs related to overweight and obese conditions are difficult to establish but are likely innumerable. They include healthcare costs, decreased productivity, reduced quality of life, and premature mortality (USDHHS, 2010; Wang et al., 2011b).

Weight-related health promotion programs have been conducted across numerous communities and have targeted a wide range of audiences. Current research suggests that when weight-related interventions target children rather than adults, long-lasting change in related health behaviors and prevention of weight-related health problems may be more likely (Fussenegger et al., 2007; Seidell et al., 2005). Not only are the origins of weight-related health problems altered more effectively in childhood, behaviors are simply more easily changed in children (Seidell et al.). Further, parental involvement in weight-related health interventions for children and adolescents may be a key contributor to their successes (Avenell and Goode, 2008; Bowman, 2005; Peterson and Fox, 2007; Philippas and Lo, 2005). Many intervention studies have indicated that changes in parents' dietary and physical activity behaviors influence their children's changes in dietary and physical activity behaviors (Blom-Hoffman et al., 2008; Chen et al., 2008; Haire-Joshu et al., 2008; Hunter et al., 2008; McCallum et al., 2007; Talpade, 2008). Parents model behaviors for their children, and they also control the availability of foods and activities in their households (Chen et al.; Haire-Joshu et al., 2008; Hunter et al., 2008; Springer et al., 2010; Talpade, 2008).

The influence of parental involvement in child and adolescent weight-related interventions has been reviewed previously (Hingle et al., 2010; Skouteris et al., 2011). Although noteworthy, the focus of these reviews has been on interventions that target specific behavior patterns (i.e. dietary behaviors) (Hingle et al.) or that aim to reduce obesity rates in a narrow preschool age range (Skouteris et al.).

The purpose of this study was to systematically review and investigate the potential parental influence of a more comprehensive collection of child and adolescent weight-related health interventions according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2009). Studies reviewed included reports of dietary, physical activity, and behavioral interventions, group and family therapies, peer influence, incentive activities, and others. Interventions that required parent participation were examined, as were those interventions that provided only an option for parents to participate and those that did not include parent participation at all. An analysis of intervention success among the three groups was conducted. In addition, considerations were made for intervention types (treatment vs. preventive), participant age groups and ranges, intervention durations, and whether interventions included single or multiple components.

Methods

Searching

In January-2011, the *EBSCOhost* database platform was used to search multiple databases, including *Academic Search Premier*, *Alt Health Watch*, *EBSCO MegaFILE*, *MasterFILE Premier*, *ERIC*, *Health Source: Consumer Edition*, *Health Source: Nursing/Academic Edition*, *MEDLINE*, *Professional Development Collection*, *PsycARTICLES*, *PsycINFO*, *Science Reference Center*, *CINAHL Plus*, and others. The following three layers of terms were utilized to search the titles of manuscripts: (child or children or childhood or schoolchildren or school or youth or adolescent or pediatric or family) and (weight or overweight or obesity or physical or fitness) and (program or programme or effect or effects or intervention or trial or treatment or prevention or school).

Selection

Peer-reviewed full-text articles written in English were included in this review. The following inclusion criteria were applied to effectively compare reports of interventions:

1. Interventions: Original interventions that targeted weight-related health and health behaviors of children or adolescents and that included children or adolescents as intervention participants, reported in January 2004 through December 2010. Secondary analyses of interventions were not included.
2. Experimental randomized controlled studies: Studies that assessed characteristics of participants who were randomized to intervention and non-participating control groups. Studies that compared multiple types of interventions were included if they also reported characteristics of a non-participating control group. Studies that reported on control groups that participated in unrelated activities or received a simple piece of related material (i.e. a pamphlet about healthy lifestyles, but not an instructional manual for weight-reduction) were also included in this review.
3. Primary intervention participants: Children or adolescents. Consistent with *Healthy People 2020*'s (USDHHS, 2011) and NHANES' (Ogden et al., 2010; USDHHS, 2006) definitions of the age range of children and adolescents, studies that included participants, aged 2 to 19 years, were included in this review.
4. Measurements: Pre-measurements, and post-measurements that were conducted immediately following the interventions, to assess the effectiveness of the interventions and that included body mass index (BMI). In order to maintain consistency, studies that did not provide data sufficient for analyses of effect sizes of intervention and control groups' BMI means were not included.

Reports of follow-up measurements of BMIs to indicate the lasting effects of interventions were considered; however, many reports did not include such measurements. Further, the lengths of time between the intervention end-dates and the dates of follow-up measurements were not consistent among reports that included follow-up data.

Only reports of interventions that actively targeted broad behavioral habits (i.e. dietary habits, physical activity habits, or sedentary activity habits) for children or adolescents in a typical setting were of interest. Therefore, reports with the following characteristics were excluded from this review:

1. Policies: Implementations of new policies or changes to existing policies.
2. Singled-out restrictions: Limits to a single and specific food or drink (i.e. sugar-sweetened beverages) or activity (i.e. television viewing).
3. Medical practices: Use of medications, medical equipment, or invasive medical procedures.
4. Participants with eating disorders: Study participants who were being treated for a documented or self-reported eating disorder.
5. Confined participants: Study participants who were institutionalized, incarcerated, or in a camp setting away from home.

It should be noted that BMI is a calculated measure and does not directly measure body composition (USDHHS, Centers for Disease Control and Prevention, 2010), thus limitations are inevitable when using BMI to assess body fat. However, the BMI measure does provide a reasonable estimation of body fatness (Steinberger et al., 2005), is a good measure of change in body composition in youth (Cole et al., 2005), and is a standardized measure that is used consistently in research literature to evaluate, among other things, the effectiveness of weight-related health interventions. Therefore, literature that employed the BMI measurement to help determine the effectiveness of interventions was included in this review.

Currently, there is no evidence that suggests that a particular sample size is necessary for intervention effectiveness. Therefore, numbers of participants within each study were not considered in the selection criteria, and data from all included studies were weighted according to sample sizes and examined collectively.

Data analysis

Data were extracted from articles that met the selection criteria. Each intervention study was weighted according to the number of participants in the experimental group, and an effect size (Cohen's *d*) of the pre–post change for each group was calculated as the standardized difference in means from pre-intervention to post-intervention BMIs. The differences between the effect sizes of the experimental and control groups were examined.

Differences were evaluated among interventions that did not include parents, interventions with optional parent participation, and interventions that required parent participation. First, Levene's test was used to test the assumption of homogeneity of variance across groups. If the test indicated that the assumption was met, standard *t*-tests or ANOVAs were conducted (significance defined as $p \leq 0.05$). If the test indicated the presence of heterogeneity of variance, the Brown–Forsythe and Welch tests were conducted in lieu of ANOVA; these are robust F-tests that are recommended when the assumption of homogeneity of variance may not be tenable.

Post hoc analyses were conducted to further examine differences between groups of interventions. In addition, correlation analyses were utilized to measure the relationships of the difference between effect sizes to intervention durations and participant age ranges, and a linear regression analysis was conducted to examine the combined contributions of intervention characteristics.

Results

The study selection process is illustrated in Fig. 1. After duplicate articles were removed, a total of 1590 studies were screened, and reports of 42 interventions among 36 research articles met the selection criteria and were included in this review. Six of the research articles reported on multiple interventions, and each intervention was reviewed separately. Study samples ranged from $n = 6$ to $n = 1029$, and the participant total was $n = 7455$.

Sample sizes of interventions were considered, as one study included fewer than 20 total participants (Melnyk et al., 2007), and five additional studies included fewer than 20 intervention participants (Davis et al., 2009; Edwards, 2005; Goldfield et al., 2006; Kitzman-Ulrich et al., 2009). Because included studies were weighted according to sample sizes, the study that included fewer than 20 total participants had a weight of less than 0.1%. The remaining six studies each had a weight of less than 1.0%. Given the rigor of the selection criteria and the value of including reports of relatively homogeneous interventions, the studies with small sample sizes were included in the meta-analysis.

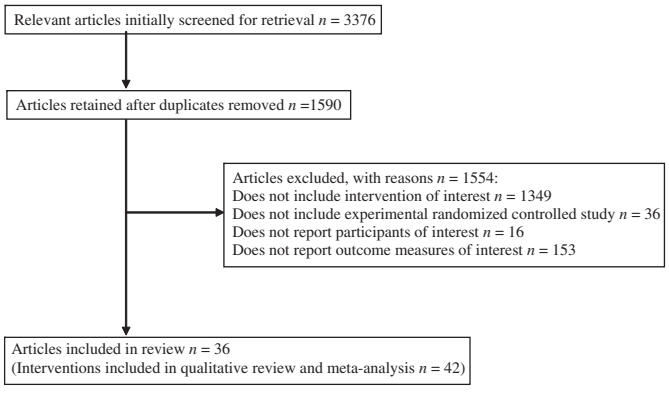

Fig. 1. Flow chart representing study selection from reports in January 2004 through December 2010. Six articles reported on multiple interventions, and each intervention was reviewed separately.

Study characteristics

A summary of study characteristics is provided in Table 1. Intervention durations ranged from nine weeks to four years. Two of the interventions reviewed included only male participants, four included only female participants, and 36 interventions included both male and female participants. Seventeen were preventive interventions, while 25 were treatment interventions for overweight or obese children or adolescents. Eight interventions targeted specific racial or ethnic populations.

Ten interventions did not include parents, nine interventions provided the option for parents to participate, and 23 required parents' participation. The intervention activities generally consisted of nutrition education, physical activity education, physical activity sessions, behavior education or behavior therapy, or a combination of these activities. Nutrition education included classroom lectures or interactive workshops, many of which provided educational materials that described the characteristics of and the benefits of healthful eating. Physical activity education generally included sessions that facilitated discussion and provided educational materials that described the characteristics and benefits of having a physically active lifestyle. During physical activity sessions, participants actually engaged in physical activity. Many interventions that included physical activity sessions encouraged the development of physical activity skills, while others simply promoted unorganized physically active play. Behavior education and behavior therapy included group sessions or individual counseling that promoted self-control and self-efficacy and encouraged behavior modification to improve dietary, physical activity, or sedentary activity habits.

Data synthesis

The Levene's test indicated evidence of heterogeneous variances across the groups of parent participation ($p = 0.034$); therefore, group differences were assessed using the Brown–Forsythe and Welch tests, both of which revealed significant differences, $p = 0.045$ and 0.033, respectively. Post hoc analyses revealed that interventions that required parent participation had greater success than interventions with no parent participation, $p = 0.027$ (weighted average differences in effect sizes = 0.30, $SE = 0.11$). Results of interventions with optional parent participation were not significantly different from results of interventions with required parent participation, $p = 0.149$, and were also not significantly different from results of interventions with no parent participation, $p = 0.963$.

Results of interventions that did not include parents and interventions with optional parent participation were combined for contrast analysis. Interventions that required parent participation had significantly greater success rates than interventions that did not include parents and interventions with optional parent participation, *t*-test $p = 0.016$.

Further analyses were conducted to examine differences between age groups of participants. Since the reviewed interventions did not consistently follow specific age ranges, studies were grouped according to the U.S. *Healthy People 2020* literature (USDHHS, 2011) and current NHANES data (Ogden et al., 2010; USDHHS, 2006), as follows: the "children" group included studies of participant groups that were aged between 2 and 12 years ($n = 21$); the "adolescents" group included studies of participant groups that were aged between 13 and 19 years

Table 1
Review of weight-related health interventions for children and adolescents, reported January 2004 through December 2010.

Study	Intervention type	Intervention duration	Participant ages	Intervention description	Parent participation	Intervention BMI change	Control BMI change	Difference between effect sizes
Alexy et al. (2006)	T	1 year	6–15 years	*Obeldicks* training program for overweight clinic patients in Germany: • PA sessions • Nutrition education • Behavior therapy	Required	1.70	−0.40	0.599
Black et al. (2010)	P	11 months	11–16 years	*Challenge!* program for black adolescents from low-income urban communities: • PA sessions • PA education • Nutrition education • Peer mentoring	Required	0.03	−0.02	0.043
Carrel et al. (2005)	T	9 months	12.0 ±0.5 years	School-based program for overweight children: • Lifestyle-focused activity skills sessions • Nutrition education	None	−1.00	0.00	−0.121
C. Davis et al. (2007) (1)	T	15 weeks	7–11 years	Program for overweight children: • 20 min/day aerobic exercise sessions • PA education • Lifestyle education • Nutrition education	Required	0.06	0.03	0.545
C. Davis et al. (2007) (2)	T	15 weeks	7–11 years	Program for overweight children: • 40 min/day aerobic exercise sessions • PA education • Lifestyle education • Nutrition education	Required	0.07	0.03	0.556
J. Davis et al. (2009) (1)	T	16 weeks	14–18 years	Clinic program for overweight Latino patients: • Culturally-tailored nutrition education	None	0.10	−0.20	0.040
J. Davis et al. (2009) (2)	T	16 weeks	14–18 years	Clinic program for overweight Latino patients: • Culturally-tailored nutrition education • Culturally-tailored strength training sessions	None	0.00	−0.20	0.024
Díaz et al. (2010)	T	12 months	9–17 years	Family-centered lifestyle intervention program for overweight adolescents in Mexico: • Nutrition education • Behavioral sessions • Physician consultations	None	1.80	−0.40	0.420
Donnelly et al. (2009)	P	3 years	Grades 2–3	*Physical Activity Across the Curriculum* (PAAC) program offered during school days: • PA sessions • PA education	None	NA	NA	0.000
Edwards (2005)	T	1 academic year	Grade 8	School-based intervention for students: • PA sessions • Nutrition education	Optional	−0.20	−0.65	0.058
Fitzgibbon et al. (2005)	P	14 weeks	48.6 ±7.6 months	*Hip-Hop to Health Jr.* for minority preschool children: • PA sessions • PA education • Nutrition education	Optional	NA	NA	−1.800
Ford et al. (2010)	T	12 months	9–17 years	Clinic program for overweight patients in England: • Nutrition education • Dietary advice • Continual nursing support	Required	0.40	0.13	0.371
Gentile et al. (2009)	P	7 months	Grades 3–5	*Switch* program for students: • PA education • Nutrition education • Behavioral support • Environment modification	Required	−0.60	−0.50	−0.055

Goldfield et al. (2006)	T	9 months	8–12 years	Hospital-based program for overweight children in Canada who regularly participated in excessive amounts of screen-time activities and who participated in limited amounts of physical activities: • Encouragement of PA • Limited TV viewing time, rewarded with allocations following completion of predetermined amounts of PA	Required	0.60	−0.30	0.192
Graf et al. (2008)	P	8 months	5–12 years	School-based *Children's Health Interventional Trial* (CHILT Project) for students in Germany: • PA education • Nutrition education • Self-management education • PA breaks during school days	None	−2.10	−1.50	−0.224
Graf et al. (2005)	P	4 years	6.7 ± 0.4 years	School-based *StEP TWO* program for overweight students in Germany: • PA sessions • PA education • Nutrition education • Related evening sessions for parents	Required	−0.27	−0.63	0.150
Jiang et al. (2007)	P	3 years	Grades 1–4	School-based program in China: • PA education • Nutrition education • Additional meetings for overweight and obese children • Lessons on modifying home activities for participants' parents	Required	−0.60	−2.80	0.686
Jones et al. (2008)	T	16 weeks	15.0 ± 1.0 years	Internet-facilitated *Student Bodies2-BED* (SB2-BED) program for overweight adolescents who engaged in overeating activities at least once/week: • PA education • Nutrition education • Weight-loss education • Related psychoeducation sessions • Behavioral sessions • Personal journaling • Face-to-face mentoring • Related handbook for participants' parents	Optional	1.82	0.65	0.269
Kain et al. (2008) (1)	P	2 years	Grades 1–8	School-based program for male students in Chile: • PA education • Active school recess periods • Nutrition education • Nutrition lessons for parents of participants in grades 4–7	Optional	−0.70	−1.20	0.105
Kain et al. (2008) (2)	P	2 years	Grades 1–8	School-based program for female students in Chile: • PA education • Active school recess periods • Nutrition education • Nutrition lessons for parents of participants in grades 4–7	Optional	−0.80	−1.40	0.130
Kalarchian et al. (2009)	T	6 months	8–12 years	Family-based program for overweight children. • Nutrition education • Behavioral sessions • Complementary sessions for participants' parents	Required	NA	NA	−0.820
Kalavainen et al. (2007)	T	6 months	7–9 years	Clinic-based family-centered program for obese children in Finland: • PA education • Nutrition education • Behavioral sessions • Healthful lifestyle training • Complementary sessions for participants' parents	Required	NA	NA	0.800
Kitzman-Ulrich et al. (2009) (1)	T	16 weeks	12–15 years	Weight-loss program for overweight adolescent females: • Nutrition education • Behavioral sessions • Psychosocial sessions • Family group therapy	Required	0.00	0.00	0.000

(continued on next page)

Table 1 (*continued*)

Study	Intervention type	Intervention duration	Participant ages	Intervention description	Parent participation	Intervention BMI change	Control BMI change	Difference between effect sizes
Kitzman-Ulrich et al. (2009) (2)	T	16 weeks	12–15 years	Weight-loss program for overweight adolescent females: • Nutrition education • Behavioral sessions • Psychosocial sessions	Required	0.10	0.00	0.333
McAuley et al. (2010)	P	2 years	5–12 years	*A Pilot Program for Lifestyle and Exercise* (APPLE) for school children in New Zealand: • Increased PA opportunities • Free filtered water and fruit offerings • Nutrition education resources	None	−0.90	−1.50	0.088
McCormick et al. (2008)	T	6.5 months	3–14 years	Community-based program for overweight children: • PA sessions • Nutrition education • Group counseling • Gift incentives	Required	−0.30	−1.20	0.215
Melin and Lenner (2009)	T	1 year	7 years	School-based program for overweight children in Sweden: • Individualized PA education • Individualized nutrition education • Lifestyle activity advice	Required	−1.90	−2.20	0.101
Melnyk et al. (2007)	T	9 weeks	15–18 years	*Creating Opportunities for Personal Empowerment* (COPE) *Healthy Lifestyles Thinking, Emotions, Exercise, and Nutrition* (TEEN) program for overweight adolescents: • PA sessions • Behavioral sessions	Required	3.97	−2.35	1.186
Murphy et al. (2009)	T	12 weeks	7–12 years	Exercise program for overweight children: • PA sessions with *Dance Dance Revolution* (DDR) equipment • Encouragement of increased participation in DDR during personal time • Pedometer provided • PA journaling	None	0.10	−0.30	0.082
Nemet et al. (2005)	T	3 months	6–16 years	Hospital-based lecture program for obese children and adolescents in Israel: • PA sessions • Nutrition education	Required	1.70	0.20	0.387
Paineau et al. (2008) (1)	P	8 months	7–9 years	Family-based program for school children in France to encourage low fat, high complex carbohydrate diets: • Nutrition education • Personal telephone nutrition counseling for participants' families • Related events for participants' families • Dedicated study website	Required	NA	NA	−0.087
Paineau et al. (2008) (2)	P	8 months	7–9 years	Family-based program for school children in France to encourage low fat, low sugar, high complex carbohydrate diets: • Nutrition education • Personal telephone nutrition counseling for participants' families • Related events for families • Dedicated study website	Required	NA	NA	−0.051
Reilly et al. (2006)	P	24 weeks	4.2 ± 0.2 years	Nursery-based *Movement and Activity Glasgow Intervention in Children* (MAGIC) program for children in Scotland: • PA sessions • Posters hung in nurseries • Health education resources for participants' families	Optional	−0.07	−0.02	−0.051
Reinehr et al. (2010)	T	6 months	8–16 years	*Obeldicks Light* program for overweight children in Germany: • PA sessions • Nutrition education • Behavioral counseling	Required	0.90	−0.80	1.019

Rosado et al. (2008)	T	12 weeks	6–12 years	Nutrition program for overweight school children in Mexico: • One serving of ready to eat cereal provided for breakfast each day for each participant • Nutrition education guide provided for each participant and her/his mother • Weekly interviews with mothers • Family consultations	Required	NA	NA	−0.435
Simon et al. (2008)	P	4 years	9–13 years	School-based program for school children in France: • Increased PA opportunities • PA education • Sedentary behavior lessons • After-school physical activity events • Parent meetings	Optional	−2.38	−2.42	−0.010
Singh et al. (2007) (1)	P	8 months	*M* = 12.7 years	School-based *Dutch Obesity Intervention in Teenagers* (DOiT) program for male Dutch students: • PA education • Behavioral sessions • Healthful food offerings	None	−0.45	−0.38	−0.035
Singh et al. (2007) (2)	P	8 months	*M* = 12.7 years	School-based DOiT program for female Dutch students: • PA education • Behavioral sessions • Healthful food offerings	None	−0.46	−0.52	−0.0002

Toruner and Savaser (2010)	P	2.5 months	Grade 4	School-based program for overweight students in Turkey:
				• Skill-building games and activities consisting of principles in
				  • Self-recognition
				  • Self-expression
				  • Nutrition
				  • PA
				  • Sedentary behavior
				  • Goal-setting
				• Lessons for participants' parents consisting of principles in
				  • Nutrition
				  • PA
				  • Sedentary behavior
				  • Related risk factors
				• Individual counseling provided for some parents
					Required	0.30	0.00	0.150

Waling et al. (2010)	T	1 year	8–12 years	Program for overweight children in Sweden: • PA education • Nutrition education • Behavioral sessions • Self-esteem lessons • Family group sessions	Required	0.00	−0.40	0.194
Weigel et al. (2008)	T	1 year	7–13 years	Hospital-based program for overweight children in Germany: • PA sessions • Nutrition education • Coping lessons • Parent meetings • Medical supervision	Required	1.50	−2.80	1.226
Yin et al. (2005)	T	4 months	Grade 4	Weight-loss program for overweight school children in Taiwan: • Preliminary open discussion about weight loss • Introductory session for participants to help design program components • PA education • Nutrition education • Related educational materials provided	None	0.12	−0.08	0.077

Note: Studies by C. Davis et al., J. Davis et al., Kain et al., Kitzman-Ulrich et al., Paineau et al., and Singh et al., reported multiple interventions that are listed separately. BMI Change = Pre-Intervention BMI − Post-Intervention BMI; positive values indicate BMI reductions. Difference between Effect Sizes = Treatment Group Effect Size for BMI − Control Group Effect Size for BMI; a positive value for Difference between Effect Sizes indicates that the treatment group had larger BMI decreases or smaller BMI increases than the control group. T = treatment intervention; P = preventive intervention; PA = physical activity; Ed = education; NA = study reported only effect sizes, and actual BMI values were not provided.

($n=4$); and the "children and adolescents" group included studies of participant groups whose ages crossed both "children" and "adolescents" ($n=17$). Since only four interventions were included in the "adolescent" group, the "adolescent" and the "children and adolescent" groups were combined, and differences in effect sizes between the combined group and the "children" group were examined. Because there was evidence of heterogeneous variances among groups (Levene Statistic $p=0.034$), group differences were assessed using the Brown–Forsythe and Welch tests, both of which revealed that the differences in effect sizes between the two groups were not significantly different, $p=0.618$ for both.

Differences between interventions with varying levels of parental involvement for the "children" group and the combined group were also considered. For both groups, there was evidence of heterogeneous variances among the groups of parental participation (Levene Statistic $p<0.001$ for the "children" group; Levene Statistic $p=0.006$ for the combined group); therefore, group differences were assessed using the Brown–Forsythe and Welch tests, both of which indicated the differences in the varying levels of parental involvement for each age group were not significant ($p=0.356$ and $p=0.153$, respectively, for "children"; $p=0.635$ and $p=0.406$, respectively, for the combined group).

Considerations were made for success rates between the two intervention types, treatment interventions and preventive interventions. The weighted contribution of the treatment interventions was relatively small, accounting for less than 10% of the entire sample; therefore, as one might expect, success rates of the intervention types were not significantly different, $p=0.385$. Success rates between treatment and preventive interventions among the "children" and among the combined "adolescents" and "children and adolescents" age groups were also considered but were not significantly different ($p=0.983$ for the "children" group; for the combined group — Levene Statistic $p=0.004$, Brown–Forsythe and Welch tests: $p=0.475$ for both).

The treatment interventions were not analyzed further; however, differences between the varying levels of parental involvement within the preventive interventions were considered. There was evidence of heterogeneous variances among the groups of parental involvement, although borderline (Levene Statistic $p=0.056$). The Brown–Forsythe test indicated a significant difference between the varying levels of parental involvement, although borderline at $p=0.054$, and the Welch test indicated a significant difference between the varying levels of parental involvement, $p=0.031$. Further, post-hoc analysis with the Games–Howell test revealed that, among the preventive interventions, those interventions that required parent participation had significantly higher success rates than interventions with no parent participation, $p=0.027$.

Success rates of interventions that included a single activity and success rates of interventions that consisted of multiple activities were not significantly different, $p=0.444$, and correlations of effect size differences with intervention durations and with participant age ranges were not significant ($p=0.079$ and 0.590, respectively). In addition, intervention durations were not significantly different among the three levels of parent participation, $p=0.219$; however, the linear combination of intervention duration and parent participation (dummy coded: 1 = required parent participation; 0 = optional or no parent participation) significantly predicted effect size differences, $R^2=0.29$, adjusted $R^2=0.26$, $p=0.001$. Both parent participation and intervention duration were significant positive predictors of intervention effectiveness, $p=0.001$ and $p=0.006$, respectively (see Table 2).

Table 2
Linear effects of parent participation and duration of treatment on intervention success.[a]

Characteristic	β	*SE*	*t*	*p*-value
(Constant)	−.350	.126	−2.79	.008
Parent participation	.420	.122	3.46	.001
Duration of treatment (months)	.011	.004	2.89	.006

[a] *Intervention Success* is measured by the positive difference in effect sizes of treatment and control participant groups, reported in January 2004 through December 2010.

Discussion

BMI reductions and weight loss have been associated with reduced insulin sensitivity, reduced rates of metabolic syndrome, and improved cardiovascular health in obese children (Birkebaek et al., 2010; Pedrosa et al., 2011; Reinehr et al., 2004; Reinehr et al., 2005) and obese adolescents (Ford et al., 2010; Reinehr et al., 2005; Wickham et al., 2009). It is therefore critical to identify factors that contribute to effective children's and adolescents' weight-related health interventions.

In the current study, findings have indicated that parental involvement in their children's weight-related interventions significantly contributes to the intervention success rates. An effect size (Cohen's *d*) of the pre–post change for each group has been calculated as the standardized difference in means from pre-intervention to post-intervention BMIs. Although Jacob Cohen (1988), the inventor of *d*, has suggested that the effect size (Cohen's *d*) of 0.2 could be considered a small effect, 0.5 a medium effect, and 0.8 a large effect, he also suggested that realistic, proven metrics be used for interpretation.

Ford et al. (2010) concluded that, in treatment interventions for overweight adolescents, a BMI reduction of 0.25 or more in standard deviation units (SD) improves insulin sensitivity, cholesterol, and blood pressure. A rough approximation of the SD of BMI of children and adolescents in the U.S. is 5.0 (Ogden et al., 2004). In the current study, the mean difference in effect size (Cohen's *d*) of interventions that required parent participation is 0.27. Therefore, the findings in this study indicate that child and adolescent weight-related health interventions that require parent participation are likely to reduce child and adolescent participants' BMIs roughly 1.2 kg/cm^2 relative to controls.

In a recent Cochrane review and meta-analysis by Waters et al. (2011), the mean differences in effect size of child obesity prevention interventions ranged from 0.09 for adolescents to 0.26 for 0 to 5 year olds. Further, interventions for 0 to 5 year olds that were conducted in the home or in a healthcare setting were more effective. Although levels of parent participation were not considered in the Cochrane review, Waters et al. conclude that the greater effectiveness seen in these non-school settings is likely related to level of parental engagement. Interestingly, the difference in effect size of interventions that required parent participation in the current study (.27) is nearly identical to the effect size of interventions of 0 to 5 year olds in the Cochrane study (.26).

A weighted majority (90.0%) of the studies included in the current review reported on child and adolescent weight-related preventive interventions; therefore, it should be noted that the primary goal of preventive interventions is *not* BMI reduction but rather the prevention of BMI increase. The findings in this current study indicate just such a preventive effect. Specifically, the average pre- to post-change for the treatment groups that required parent participation was a BMI increase of 0.28 kg/cm^2; the average change for the control groups in these studies was a BMI increase of 1.17 kg/cm^2, a difference of 0.89 kg/cm^2. In other words, child and adolescent participants of weight-related interventions that required parent participation gained, on average, 0.89 kg/cm^2 less than the respective control groups' participants. Participants of interventions that included no or optional parent participation gained, on average, 0.76 kg/cm^2, while the respective control group participants gained, on average, 0.93 kg/cm^2, a difference of 0.17 kg/cm^2.

McGarvey et al. (2006) noted that, when attempting to shape their children's health habits, parents generally *want* to do what is good for their children; however, some parents simply do not understand the relationships between dietary intake, physical activity, body weight, and the related health risks. For those parents who do understand such relationships, their parental practices may be influenced by family, culture, and the media (McGarvey et al.).

Maffeis et al. (1998) suggested that the main risk factor for childhood obesity was obesity of parents. More recently, Lazzeri et al. (2011) found significant relationships between BMIs of parents and their children, and Niemeier and Hektner (in press) concluded in a study of young adults that, along with parental authority styles, parents' dietary behaviors and BMIs influence the lasting dietary behaviors and BMIs, respectively, of their children. A meta-analysis by Wang et al. (2011a) revealed a weak but significant positive correlation between parents' and their children's dietary behaviors, and Collins et al. (2011) provided evidence indicating that parent-centered dietary programming was a key contributor to prolonged reductions in BMIs of child intervention participants.

In this study, evidence has been provided to indicate that weight-related health interventions that target children and adolescents are more successful when parents are required to participate in intervention activities. This finding holds true when only preventive interventions are considered and treatment interventions are excluded. The findings of this study are consistent with one of the findings reported by Hunter et al. (2008). In a family-based treatment for overweight and obesity, parents' attendance at behavior therapy sessions was a significant predictor of decreases in children's BMIs (Hunter et al.). In addition, parents' weight loss was the greatest predictor of children's BMI reductions, accounting for 18.8% of the children's BMI changes (Hunter et al.).

Previous reviews have also suggested that both parent behaviors and parent involvement in interventions are consistently positively associated with children's and adolescents' healthy weight-related behaviors (Avenell and Goode, 2008; Bautista-Castaño et al., 2004; Bowman, 2005; Caroli et al., 2004; Golley et al., 2011; Lansky and Vance, 1983; Peterson and Fox, 2007; Philippas and Lo, 2005; Roberts, 2000). The current study further indicates that children's and adolescents' actual BMI reductions are greater in interventions that require parent participation, even when controlling for duration of interventions. In addition, the duration of interventions, along with parent participation, contributes independently to intervention success rates.

Current reports of interventions that indirectly target children and adolescents by encouraging behavior change among parents are limited but have illustrated results of improved eating and physical activity behaviors for entire families and improved weight for parents and their children (Blom-Hoffman et al., 2008; Chen et al., 2008; Collins et al., 2011; Haire-Joshu et al., 2008; Hunter et al., 2008; McCallum et al., 2007; Talpade, 2008). Additional studies of interventions that target parents as the *active participators* in intervention activities and their children as the *passive beneficiaries* of intervention effects would be beneficial. Such studies could attempt to elucidate the mechanisms by which parents contribute to their children's weight-related behaviors. Studies of interventions that seek input from parents and their children during intervention design would also be worthwhile (Morabia and Costanza, 2010), and an exploration of optimal intervention durations and intensities among specific age groups would be beneficial. Also warranted are detailed comparisons of preventive and treatment interventions, and reviews of interventions that measure long-lasting intervention effects are needed.

Study limitations and strengths

A limitation that should be noted in this study is in the lack of ability to clearly distinguish between participant age groups. It is likely that intervention approaches differ between children and adolescents; however, although limited age-group categorization was possible, differences between them did not emerge. It is unclear whether the lack of significant differences between the two age groups was related to the absence of success rate differences or the unclear differentiation of the age groups.

Also, relatively few of the interventions included in this study were treatment interventions that aimed to improve weight statuses of overweight or obese children and adolescents. This is, at least in part, because the sample sizes of treatment interventions tended to be smaller than sample sizes of preventive interventions. Since the analyses in this study were based on weighted effect sizes according to interventions' sample sizes, the relative contribution of treatment interventions was quite small. Detailed analyses of treatment interventions were not possible; however, it seems likely that parents of obese children may have a greater motivation to help their children improve their weight statuses.

Reviews and meta-analyses are predisposed to a certain level of heterogeneity bias that could influence study results. In the current study, in order to minimize study heterogeneity and ensure comparability of studies, strict inclusion criteria were applied. However, because of the wide range of participant ages and, resultantly, BMIs, heterogeneity exists in this study, and calculating a quantitative index to demonstrate the level of study heterogeneity would not be worthwhile. Therefore, it should be noted that a risk of misinterpretation in this study does exist.

The current review and meta-analysis, like most such studies, may contain a level of error due to publication bias. It is possible and likely that studies with significant results are published more frequently than studies without significant results. In the current study, numerous intervention studies have been screened and included, and some of the included studies did not contain significant results. However, the potential for misinterpretation due to the possible bias of published studies should be considered.

In addition, like all reviews and meta-analyses, the current study used a cut-off date. Studies with publication dates that spanned across eight years were included, and allowing for more flexibility in the inclusion criteria in order to potentially consider more dated studies could have posed a threat to the timeliness of study conclusions. However, it should be noted that the cut-off date could have prevented the inclusion of other relevant studies.

An important societal health issue has been explored in this study, and it provides a useful contribution to literature across disciplines. A key strength is in the rigor of the methodology. The comprehensive review of intervention studies and the meta-analysis of related data have offered a practical approach to address questions about influences of intervention effectiveness, particularly related to parent participation. In addition, multiple other considerations were made, including age ranges, types of interventions, comprehensiveness of interventions, and intervention durations, all while addressing the questions of parental influence according to varying levels of parental participation.

Conclusions

A remarkable opportunity for long-term health behavior change exists during childhood and adolescence (Seidell et al., 2005). Because child and adolescent weight-related health behaviors along with the associated health consequences typically persist into adulthood (Heath and Panaretto, 2005; Serdula et al., 1993; USDHHS, 2010; Yancey and Kumanyika, 2007), success of children's and adolescents' weight-related health behavior interventions is critical to reducing the incidence of health risks for individuals. This study has illustrated that parental involvement contributes to the success of such interventions. Further, this study provides a gateway for continued research on parental contributions to children's weight-related health behavior change strategies, and it supports the development and testing of interventions that focus primarily on parents to aid them in helping their children develop positive weight-related health behaviors.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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