Original Article

Systematic Review of Multicomponent Interventions with Overweight Middle Adolescents: Implications for Clinical Practice and Research

Stephanie A. Kelly, RN, MS, FNP-BC, Bernadette Mazurek Melnyk, RN, PhD, CPNP/NPP, FAAN, FNAP

ABSTRACT

Background: Being overweight is a global epidemic that occurs in more than 10% of school-aged children (age 5–17) worldwide. The rate of adolescents being overweight continues to rise despite numerous public health campaigns and programs to increase awareness and modify unhealthy lifestyle patterns.

Aims: The purpose of this systematic review was to determine the most efficacious intervention for treating overweight adolescents. Evidence from this systematic review could guide clinical practice and future research with this high-risk population in youth.

Methods: In adolescents of 13–17 years of age who are above ideal body weight, are multicomponent interventions that integrate nutrition, activity, and behavioral components more efficacious than any type of comparison group in improving weight, body mass index (BMI), percentage body fat, or behaviors of dietary intake or activity level? Literature searches were completed in Cochrane Library, MEDLINE, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and PsycINFO databases as well as hand searching.

Results: Due to a lack of consistency among the studies regarding methods and rigor of the studies, the evidence is not entirely clear on the best multicomponent program for addressing overweight in middle adolescents. The success of an intervention was associated with the dose of the intervention received by the adolescent and parent.

Conclusions: A structured program addressing nutrition, physical activity, and behavioral skills appears to be efficacious in reducing weight and cardiovascular risk factors. Primarily, interventions have included the individual and varying degrees of parental participation. In the past few years, more research has addressed the multiple levels of the ecological model. Further research addressing the five levels of the ecological model will assist in illuminating the impact of the environment on behavior change in adolescents.

KEYWORDS obesity, overweight, adolescents, systematic review, randomized controlled trials

Worldviews on Evidence-Based Nursing 2008; 5(3):113–135. Copyright ©2008 Sigma Theta Tau International

BACKGROUND

The prevalence of overweight in adolescents is steadily increasing. Overweight is a global epidemic (Caballero 2007) occurring in more than 10% of school-aged children (5–17 years) around the world (Lobstein et al. 2004). The rate of obesity in adolescents continues to rise despite public health campaigns and programs to increase awareness and modify unhealthy lifestyle patterns (Ogden et al. 2006). Furthermore, the prevalence of obesity is increasing in adults, with more than 1 billion overweight adults worldwide (World Health Organization 2000). The

Stephanie A. Kelly, *Doctoral Candidate, Arizona State University College of Nursing and Healthcare Innovation, Phoenix, Arizona;* **Bernadette Mazurek Melnyk,** *Dean and Distinguished Foundation Professor in Nursing, Arizona State University College of Nursing and Healthcare Innovation, and Associate Editor, Worldviews on Evidence-Based Nursing, Phoenix, AZ.*

Address correspondence to Stephanie A. Kelly, Arizona State University, College of Nursing and Healthcare Innovation, 500 North 3rd Street, Phoenix, AZ 85004; stephanie.vanblankenstein@asu.edu

Accepted 27 May 2008

1545-102X1/08

estimated cost of overweight each year is more than $100 billion in the United States (US) alone (Finkelstein et al. 2005).

Obesity has increased over the past few decades as people have become more sedentary. This trend of limited physical activity, coupled with changes in food consumption, has influenced the prevalence of obesity in adolescents. Specifically, a decline in physical activity is noted in adolescents, especially in female adolescents (Goran et al. 1998, U.S. Department of Health and Human Services 2000; Kimm et al. 2002; Pahkala et al. 2007).

The current generation of children and adolescents might be the first in nearly a decade who will have a shorter life expectancy than their parents had (Olshansky et al. 2005), in part, because of the rampant rise in obesity in children and adolescents. Indications are that the current generation of children will become the most obese generation of adults in history (Hill & Trowbridge 1998).

Overweight adolescents have a variety of adverse health consequences and are at a greater risk for sleep apnea, orthopedic problems, polycystic ovarian disease, endocrine abnormalities, nonalcoholic fatty liver disease, and cardiovascular disease (CVD) risk factors (Zametkin et al. 2004; Choudhary et al. 2007). CVD is known to begin in adolescence (McGill et al. 2002), and continues to be the primary cause of death in Americans (Minino et al. 2007) and people from other developed countries.

The cause of obesity is understood to be multifactorial (Anderson & Butcher 2006; Rosenbaum 2007), including factors within the individual, interpersonal, community, organizational, and policy levels of the ecological model. Few investigators have tested an ecological perspective related to adolescent health behaviors. Environmental influences are increasingly being studied with factors such as the family, built, and school environments that may further illuminate the best treatment strategies for obesity in adolescence (Elder et al. 2007; Villard et al. 2007). Little evidence exists to support interventions that do not include both dietary changes and physical activity (Jelalian & Saelens 1999). The use of multicomponent interventions has been associated with greater positive changes in health outcomes in adolescents (Jelalian & Saelens 1999). In addition, the use of behavior modification skills in programs for the treatment of obesity in adolescence appears to be linked to better outcomes (Saelens et al. 2002; Boon & Clydesdale 2005).

A lot of research for the treatment of obesity has been focused on children younger than 13 years (Summerbell et al. 2003; Doak et al. 2006; Flodmark et al. 2006; Snethen et al. 2006; Stice et al. 2006). Furthermore, it is well documented that overweight in middle adolescence or later is highly predictive of obesity in adulthood (Ferraro et al. 2003; Gordon-Larsen et al. 2004; Deshmukh-Taskar et al. 2006) and strongly correlated with CVD in middle age (Must et al. 1992). Therefore, in order to implement best practices with this population of youth, a review of the evidence on the most efficacious interventions for the treatment of obesity during this critical time in development is important.

AIMS

This systematic review was undertaken for the purpose of identifying and synthesizing published research worldwide for the most efficacious treatment of obesity in middle adolescence. Evidence from this integrative review can be used as a guide for clinical practice and future research with this high-risk population.

METHODS

Review Method

We used guidelines published by the Centre for Reviews and Dissemination (CRD; Khan et al. 2001) to conduct this review. All phases were completed by the primary author, with review and consultation by the second author. Nine phases were conducted: (1) identification of need for review, (2) proposal preparation for systematic review, (3) development of review protocol, (4) identification of research, (5) selection of studies, (6) assessment of study quality, (7) data extraction, (8) data synthesis, and (9) preparation of the manuscript.

The following question guided the search for evidence: in adolescents of 13–17 years of age who are above ideal body weight, are multicomponent interventions that integrate nutrition, activity, and behavioral components more efficacious than any type of comparison intervention in improving weight, body mass index (BMI), percentage body fat, or behaviors of dietary intake or activity level?

Identification of Research

A comprehensive literature search was conducted from 1980 through December 2007 to locate studies targeting treatment of obesity in adolescents. The searches were conducted in the Cochrane Library, MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and PsycINFO databases. Hand searching was completed in *The International Journal of Pediatric Obesity* (2006–2007), *The International Journal of Obesity* (2006–2007), articles referenced in studies used for this review, and seven published syntheses/meta-analyses (Summerbell et al. 2003; Summerbell et al. 2005; Doak et al. 2006; Flodmark et al. 2006; Flynn et al. 2006; Snethen et al. 2006; Stice et al. 2006).

The criteria for inclusion in this review were: (1) a randomized controlled trial (RCT), (2) middle adolescents (ages 13–17), and (3) a multicomponent intervention that included physical activity, nutrition, and behavior modification. Studies were excluded from this review if: (1) conducted in an in-patient setting, (2) age of participants spanned a range greater than 6 years, (3) participant age range did not include at least 2 years in middle adolescence (13–17), (4) the mean age of participants was less than 13 years, (5) in junior/middle school if mean age was not included, (6) a medication study, or (7) a study with obese adolescents related to a medication side effect.

Search words and limits varied slightly in each database. For example, pre-set age limits for CINAHL and MEDLINE were 13–18 years, while the limit in PsycINFO was 13–17 years. An evaluation for inclusion in this review included assessing citation titles and abstracts. If the citation title indicated any intervention with adolescents without clear exclusion, the abstract was reviewed for the inclusion criteria. Full-text articles were retrieved for all articles that appeared to meet the criteria and were evaluated. All articles meeting the study criteria were included.

Selection of Studies

The databases were searched using the relevant terms. In the Cochrane Library, 30 citations were identified with keyword searches of overweight and obesity. From these searches, two systematic reviews were identified providing a comprehensive review of RCTs for the prevention and treatment of obesity in all age groups of children. The first systematic review for the treatment of obesity in children (Summerbell et al. 2003) included two studies with middle adolescents (Mellin et al. 1987; Wadden et al. 1990). The second systematic review for the prevention of obesity in children (Summerbell et al. 2005) included one study with middle adolescents (Neumark-Sztainer et al. 2003).

In MEDLINE, using MeSH search words of overweight or obesity, with limits of humans, English text, ages 13–18 years, RCT, and years 1980–2007, 386 studies were found. Articles were rejected if titles indicated drug studies, diabetic patients, instrument testing, adults, mental illness, polycystic ovarian disease, or nonrandomized controlled trials. Sixty-one abstracts were reviewed, of which 30 were determined to not meet the study criteria. Thirty-one studies were retrieved, of which 10 did not meet the review criteria. Twenty-one manuscripts, about 14 studies, were identified that met the established inclusion criteria (Brownell et al. 1983; Dewolfe & Jack 1984; Mellin et al. 1987; Wadden et al. 1990; Gutin et al. 2002; Saelens et al. 2002; Neumark-Sztainer et al. 2003; Balagopal et al. 2005; Jiang et al. 2005; Resnicow et al. 2005; Williamson et al. 2005; Jelalian et al. 2006; Williamson et al. 2006; Park et al. 2007).

In PsycINFO, using keywords of obesity or overweight, with limits of English text, years 1980–2007, adolescent of 13–17 years, and clinical trial, 17 studies were identified; 14 were eliminated by title content including mental illness and nonrandomized controlled trial. Three articles met the study criteria; however, these also were identified in MEDLINE (Resnicow et al. 2005; Williamson et al. 2005; Williamson et al. 2006), with two reporting on the same study (Williamson et al. 2005; Williamson et al. 2006).

In CINHAL, 19 studies were identified with MeSH search word of obesity or keyword of overweight, and limits of English text, years 1980–2007, ages 13–18 years, and clinical trial; 17 studies were excluded based on title. One abstract and one article were retrieved for review with neither study meeting the inclusion criteria. Hand searching identified three studies (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Emes et al. 1990).

Seventeen studies from all databases searched met the inclusion criteria (see Table 2; Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Brownell et al. 1983; Dewolfe & Jack 1984; Mellin et al. 1987; Emes et al. 1990; Wadden et al. 1990; Gutin et al. 2002; Saelens et al. 2002; Neumark-Sztainer et al. 2003; Balagopal et al. 2005; Jiang et al. 2005; Resnicow et al. 2005; Williamson et al. 2005; Jelalian et al. 2006; Williamson et al. 2006; Park et al. 2007).

Study Quality Assessment

A coding tool to assess quality of the articles was created by synthesizing two previously developed tools from the CRD(Khan et al. 2001; Melnyk & Fineout-Overholt 2005b; see Table 3). Article quality was quantified by assessing 12 categories, with a high score of 3 and a low score of 0 for each category. The quality scores ranged from 10 to 27. The mean and standard deviation (*SD*) of the quality scores for the 16 studies were 18.6 and 5.2, respectively.

Randomization in a study is important in that it strengthens the internal validity. Two studies cited the use of random assignment of participants to treatment group (Saelens et al. 2002; Jelalian et al. 2006). Likewise, two studies cited concealment of the random treatment allocation (Balagopal et al. 2005; Resnicow et al. 2005).

For two treatment groups to be properly compared on outcomes in a study, their baseline characteristics should be similar. All authors but one cited a comparison of the baseline characteristics (Coates, Killen et al. 1982). The majority of studies ($n = 9$) prestratified participants before randomization on a measure of weight (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Brownell et al. 1983; Wadden et al. 1990; Gutin et al. 2002; Saelens et al. 2002; Balagopal et al. 2005).

TABLE 1
Outcomes comparison of multicomponent interventions

		OUTCOMES MEASURED											
SIGNIFICANT EFFECT AUTHOR YEAR	**SIGNIFICANT BETWEEN-GROUP FINDINGS**	**BMI, BMI PERCENTILE AND/OR BMI Z-SCORE**	**WEIGHT**	**HEIGHT**	**BODY COMPOSITION (PERCENTAGE BODY FAT)**	**PERCENTAGE ABOVE IDEAL WEIGHT PERCENTAGE OVERWEIGHT AND/OR RELATIVE WEIGHT**	**BP/ CHOLESTEROL**	**PHYSICAL ACTIVITY**	**NUTRITION**	**BEHAVIOR/ SKILLS**	**KNOWLEDGE**	**SELF-ESTEEM DEPRESSION**
Coates, Jeffery et al. 1982	↔		√			√	√					
							√					
Coates, Killen et al. 1982 (parent)	↔		√	√		√	√	√	√			
Brownell et al. 1983	↓	√	√	√		√						
						↓	√					
Dewolfe and Jack 1984	No statistical comparison of groups reported		√	√	Skin fold √							
Mellin et al. 1987	No between-group findings reported		√	√		√		√	√		√	√
												√
Emes et al. 1990	↔	√	√	√								
Wadden et al. 1990	↔	√	√	√	DEXA √		√					√
							√					√
Gutin et al. 2002	↓		√	√	DEXA √		√	√	√			
							↓					
							√					
							↓					
[a]Saleans et al. 2002	↓	√	√	√				√	√	√		
		↓								↑		
Neumark-Sztainer et al. 2003	↔	√	√	√					√			
Balagopal et al. 2005	↓	√	√	√	√		√					
		↓	↓		DEXA ↓		↓					
Resnicow et al. 2005	↔	√	√		BIA √		√					
							√					
[b]Williamson et al. 2005	↓	√	√	√	√				√			√
					DEXA ↓							√

(Continued).

TABLE 1
Outcomes comparison of multicomponent interventions

SIGNIFICANT EFFECT AUTHOR YEAR	SIGNIFICANT BETWEEN-GROUP FINDINGS	OUTCOMES MEASURED										
		BMI, BMI PERCENTILE AND/OR BMI Z-SCORE	WEIGHT	HEIGHT	BODY COMPOSITION (PERCENTAGE BODY FAT)	PERCENTAGE ABOVE IDEAL WEIGHT PERCENTAGE OVERWEIGHT AND/OR RELATIVE WEIGHT	BP/ CHOLESTEROL	PHYSICAL ACTIVITY	NUTRITION	BEHAVIOR/ SKILLS	KNOWLEDGE	SELF-ESTEEM DEPRESSION
Jiang et al. 2005	↓	√ ↓	√ ↓	√			√ ↓ √ ↓		√ ↓			
Jelalian et al. 2006	↔	√	√	√			√ ↓					
Park et al. 2007	↓	√ ↓	√ ↓	√	BIA √ ↓		√ ↓ √ ↓		√			

Note. [a]Primarily telephone sessions; [b]Primarily internet sessions; √outcome measured; ↔no significant change; ↓ ↑direction of significant change BIA, Bioelectrical Impedance; DEXA, Dual energy x-ray absorptiometry.

Because the received dose of an intervention is the key to outcome results in a study, reporting intervention compliance of participants is important. Seven authors reported participants' compliance (Mellin et al. 1987; Wadden et al. 1990; Gutin et al. 2002; Saelens et al. 2002; Resnicow et al. 2005; Jelalian et al. 2006; Park et al. 2007). In all but three studies, authors reported the means and *SD*s of primary outcome measures (Wadden et al. 1990; Balagopal et al. 2005; Jelalian et al. 2006). The majority of authors analyzed data in the groups in which the participants were randomized, but often did not include those who did not complete the intervention. In five studies, authors reported an intention-to-treat analysis (Saelens et al. 2002; Balagopal et al. 2005; Resnicow et al. 2005; Jelalian et al. 2006; Williamson et al. 2006). Most authors did not report how missing data waere handled; those who addressed the missing data were Dewolfe and Jack (1984), Mellin et al. (1987), Saelens et al. (2002), Jelalian et al. (2006), and Williamson et al. (2006). Most authors addressed sample size preintervention, postintervention, and at follow-up, although few reported reasons for participant attrition. Three authors did not report loss to follow-up (Coates, Jeffery et al. 1982; Gutin et al. 2002; Balagopal et al. 2005). Because a paucity of research reports are available concerning middle adolescents, all studies were retained in this review regardless of the study quality. The quality characteristics have been discussed to indicate limitations in interpreting the data.

Data Extraction and Analysis

Data extraction was guided using a modified template from CRD (Khan et al. 2001; see Table 4). Data were extracted by the first author, with an additional table created to track significant results in each study. Each article was read a minimum of three times to extract the necessary components.

Data were analyzed by creating a spreadsheet to facilitate compilation of study findings. Effect sizes were calculated using Cohen's D formula.

RESULTS

Demographics of Study Samples

Ages of the participants ranged from 12 to 20 years (mean 14.5). Most studies were not ethnically diverse. Of those in which ethnicity was reported, four included primarily, or only, African-American adolescents (Wadden et al. 1990; Gutin et al. 2002; Resnicow et al. 2005; Williamson et al. 2005), and four included mostly Caucasian adolescents (Brownell et al. 1983; Mellin et al. 1987; Saelens et al. 2002; Jelalian et al. 2006). One study had a culturally diverse sample that included: 26.7% Caucasian, 29.4%

TABLE 2
Systematic review table of multidimensional programs for overweight middle adolescents

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
1982 Coates, Jeffery	RCT 2 × 2 factorial design	Intervention duration: 15 weekly sessions with additional 5 weeks of weigh in. 60 minutes each session.	No significant difference between group effects.	Strengths:
Northern California	Group 1: daily weight		20 weeks: post intervention	Parent component
$n = 38$, age 13–17	Group 2: daily calorie count	Follow-up: 6 month	Decrease in percentage overweight	Attrition <20%
12 males, 26 females	Group 3: weekly weight	Measures:	Daily weight ES: 0.59	No significant differences at baseline between groups
Mean weight 81.2 kg	Group 4: weekly calorie count	Body weight	Weekly weight ES: 0.21	Limitations:
Average percentage overweight 40.6	Program content same for all subjects. Behavioral skills, nutrition, and exercise.	Blood pressure	Daily calorie ES: 0.25	Small sample size
Presumed clinic-based	Parental participation: attend final group meeting	Lipid panel		Not theory based
	Groups leaders: BS in psychology and a 1st-year doctoral student in clinical psychology	Satisfaction measures	6 months: follow-up	No comparison group receiving active component
			Decrease in percentage overweight	Short-term weight loss was assessed
			Daily weight ES: 0.32	
1982 Coates, Killen	RCT	Intervention duration: 20-week program with 18 sessions (nearly weekly)	No significant difference between group effects.	
$n = 31$, mean age 15.6	Randomly assigned to either parent participation or no-parent participation		20 weeks: Post intervention	Strengths: Parental component
Age 13–17				
11 males, 20 females	Program content same for all teen subjects. Behavioral skills, nutrition, and exercise	Follow-up: 9 month	Calorie reduction	No significant differences at baseline between groups
Northern California (Stanford)	Parental component: weekly sessions focusing on support skills and how to assist adolescent.	Measures	Parent group ES: 0.51	Limitations:

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
Presumed clinic-based	Group leaders: not reported.	Weight: measured daily Percentage above ideal body weight	Nonparent group ES: 1.16 Reduction in cholesterol intake	Small sample size Not theory based
		Satisfaction	Parent group ES: 9.29	No comparison group receiving active component
		Lipid panel	Nonparent group ES: 9.39	Attrition not reported
		Dietary questionnaire	9 months: follow-up similar finding to post intervention	Reliability and validity of measures not reported
		Self-report physical activity		Short-term weight loss was assessed
1983, Brownell et al. Williamsport, PA	RCT Group 1: mother and child intervention separate	Intervention duration: 16 weekly sessions with	4 months: post intervention Significant difference in weight between mom child separate and child only.	Strengths: Parental component
$n = 42$, mean age 13.8	Group 2: mother and child intervention together	6 bimonthly sessions. 45–60 minutes each session.	16 months: follow-up	Manualized intervention
Age 12–16	Group 3: child alone	Follow-up: 16 month	Significant difference between percentage overweight in mom child separate and mom child together/child only groups.	Attrition <20%
9 males, 33 females	Program content same for all teens	Measures		No significant differences at baseline between groups
Mean BMI 43.3	Behavioral skills, nutrition, and exercise	Weight: mom's and teens		Limitations:
Presumed clinic-based	Groups leaders: psychologists	Height/BP Percentage above average weight		Small sample size Not theory based
		Index for developmental growth		No comparison group receiving active component
1984, Dewolfe & Jack	RCT of follow-up intervention	Intervention duration:	No significant between group effects reported at follow-up	Strengths:
Kingston, Canada	Intervention ($n = 29$):	8 weeks with two sessions per week.	8 weeks: post intervention	Parental component
$n = 29$, mean age 15.9	Program content same for all teens	Follow-up: either monthly or at 12 months.	No difference between groups in weight lost after randomization to follow-up groups	No significant differences at baseline between groups
Age 14–20	Behavioral skills, nutrition, and exercise	Measures	12 months: follow-up	12 months follow-up to assess long-term weight loss

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
All female	Parental involvement: One session during week 7 of intervention	Body weight	Weight loss	Limitations:
Mean weight 70.9 kg	Follow-up (all subjects who completed intervention [$n = 15$]):	Height	Group 1 ES: 0.37	Small sample size
School-based	Group 1: monthly measures and behavior reinforce	Skin fold	Group 2 ES: 0.24	Not theory based
	Group 2: monthly measures	Standardized fitness test		No reported use of manualized intervention
	Group 3: measures only at 12 months	Calculate percentage body fat		Attrition >20%
	Group leaders: physical education teacher, M.S., prepared nurse, and RPDt			
1987, Mellin et al.	RCT	Intervention duration:	No significant difference between group effects.	Strengths:
Northern California	Experimental: SHAPEDOWN curriculum	14 weekly sessions. 90 minutes each session.	3 months: post intervention and 15 months: follow-up	Manualized intervention
$n = 66$, mean age 15.6 yrs	Control: wait list control	Follow-up: 15 months	Significant difference within group *t*-test for experimental group: knowledge, self-esteem, depression, behavior, and relative weight.	Transferability: no significant differences between the four sites of intervention
Age 12–18	Program content: behavioral skills, nutrition, and exercise	Measures	Significant difference within group *t*-test for control group: self-esteem	Attrition <20%
Mean weight 78.2 kg	Parental participation: two sessions to support changing diet and activity patterns for family and improve parenting and communication skills	Height and weight		No significant differences at baseline between groups
Clinic-based: 4 sites	Group leaders: female nutritionist	Habit inventory		Parental component
		Rosenberg's Self-Esteem and Depressive Affect Scale		Limitations:
				Not theory based
		SHAPEDOWN knowledge		Comparison group not attention controlled
		Weight management strategies during program		

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
1990, Emes et al.	RCT	Intervention duration:	No significant difference between group effects.	Strengths:
Alberta, Canada	Treatment conditions:	12 weeks daily.	12 weeks: post intervention	No significant differences at baseline between groups
$n = 33$, mean age 13.2	Aerobic exercise (AE), nutritional education and behavior modification (NEBM), and lifestyle counseling (LC).	Follow-up: none	Reduction in BMI	Reliable and valid measures
Age 12–15	Group 1: fast-start AE (AE, NEBM)	Measures	Group 1 ES: 0.33	Limitations:
9 males, 24 females	Group 2: slow-start AE (AE, LC, NEBM)	Height and weight	Group 2 ES: 0.51	No parent component
Mean percentage above ideal weight: 48% (20–96%)	Group 3: lifestyle counseling (LC, NEBM)	Skin fold measures	Group 3 ES: 0.25	Not theory based
Clinic-based	Parental participation: none	Girth measurements	Reduce percentage overweight	Small sample size
	Group leaders: certified fitness instructors. Certified nutritionist, and licensed psychologist.	Physical work capacity	Group 1 ES: 0.47	Attrition >20%
		Canada fitness test	Group 2 ES: 0.86	Short-term weight loss was assessed
			Group 3 ES: 0.37	
1990, Wadden et al.	RCT	Intervention duration:	No significant difference between group effects.	Strengths:
Philadelphia, PA	Group 1: mother and child intervention separate	16 weekly sessions and 6 monthly follow-up sessions	16 weeks: post intervention	Parent component
Presumed clinic-based	Group 2: mother and child intervention together	Each session 1 hour	Significant decrease in weight only when all groups combined	Manualized intervention
$n = 47$, mean age 13.8	Group 3: child alone	Follow-up: none	10 months: follow-up	No significant differences at baseline between groups
Age 12–16	Program content same for all teens	Measures	Each group exceeded their pretreatment weight.	Limitations:
Presumed clinical setting	Behavioral skills, nutrition, and exercise	Weight/body composition		Not theory based
Mean BMI 35.6	Group leaders: psychologists	Cholesterol/BP		Small sample size
		Piers-Harris Self-Concept Children's Depression Index		Attrition >20%
				No comparison group receiving active component

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
2002, Gutin et al.	RCT	Intervention duration:	Significant difference between group effects.	Strengths:
Georgia	Group 1: lifestyle education (LSE)	8 months	8 months	Adequate sample size
$n = 80$, mean age 14.91	Group 2: LSE and moderate physical activity (PA)	Measures	Significant improvement in CV fitness, DBP, TC/HDL ratio, LDL particle size and triglycerides for high PA compared with LSE only	Limitations:
Age 13–16	Group 3: LSE plus high PA	Lipids with subfractions		Significant differences at baseline between groups related to gender and ethnicity
Mean percentage body fat >40%	Program content:	DEXA		Not theory based
Clinic-based: Georgia Prevention Clinic	LSE: behavior modification/skill building, nutrition, and psychosocial factors r/t overweight	MRI for visceral adipose tissue measure		Attrition not reported
	Moderate PA: 55–60% of peak VO_2.	Multistage treadmill test—VO_2 max		
	High PA: 75–80% of peak VO_2.	7-day physical activity recall		
	Parental participation: none	Dietary 2-day recall		
	Group leaders: not reported			
2002, Saelens et al.	RCT	Intervention duration:	Significant difference between group effects.	Strengths:
Southern California	Experimental group: healthy habit (HH)	4 months	4.1 months: post intervention	Parental component
$n = 44$, mean age 14.2	Control group: typical care (TC)	Follow-up: Average 7.2 months.	Significant effect between groups for BMI z scores	No significant differences at baseline between groups
Age 12–16	HH: Initiated in primary care with one focused counseling session by pediatrician. Telephone calls weekly × 8 then biweekly × 3 calls. Behavioral skills, nutrition, and exercise.	Measures	ES: 0.4	Innovative approach with study methods (phone calls)
26 males, 18 females	TC: one general session with a pediatrician following expert committee recommendations	Weight and height	7.2 months: follow-up	Manualized intervention
Average BMI 30.7. All had BMI >89th percentile	Parental participation: mailed information from adolescent's manual with tips for reinforcing behavior change.	Diet recall and PA	Significant effect between groups for BMI z scores	Limitations:

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
Clinic-based	Group leaders: nutritionist or psychologist	Sedentary behavior Three-Factor Eating Questionnaire Children's Eating Attitude Test The Killen Weight Concerns Scale Physician counseling evaluation Behavior skill use	Effect size: 0.35 HH group report higher overall and eating-related behavioral skill use (i.e., self-monitoring and stimulus control)	Not theory based Small sample size Attrition not reported Not equal attention control for comparison group Short-term weight loss was assessed
2003, Neumark-Sztainer et al.	RCT feasibility study	Intervention duration: one semester (16 weeks) and 8 weekly follow-up sessions	No significant difference between group effects.	Strengths:
Twin Cities Minnesota	Experimental group: daily physical education.	Follow-up: 7 months		Parental component
$n = 201$, mean age 15.4	Control group: distribution of written materials on healthy eating and PA	Measures		No significant differences at baseline between groups
Grades 9–12	Program content:	Physical activity		Attrition <20%
Mean BMI 26.7	Behavioral skills, nutrition, social support, and exercise.	Food Frequency Quest.		Accessibility to students
School-based: 6 high schools	Parent participation: postcards sent containing information on PA, social support and nutrition	BMI		Theory-based
	Group leaders: new moves coordinator, physical education teacher, community guest instructor	Harter Self Perception Subscale Numerous additional subscales Qualitative analysis		Manualized intervention Limitations: Allocation by unit, but evaluation by individual Not equal attention control for comparison group
2005, Balagopal et al.	RCT	Intervention duration:	Significant difference between group effects	Strengths:
Jacksonville, Florida	Experimental: based on SHAPEDOWN	3 months		Parental component
$n = 15$, mean age 15.8	Control: requested to not change lifestyle regarding PA and food intake	Follow-up: none		Manualized intervention

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
Mean BMI obese: 39.5	Program content:	Measures		No significant differences at baseline between groups
Clinic-based	Behavioral skills, nutrition, and exercise.	Weight and height		Limitations:
	Parental participation: Family invited to participate in exercise session once a week	DEXA scan for percentage body fat		Not theory based
	Group leaders: nutritionist and a clinical psychologist.	CRP IL-6 Lipid panel		Small sample size Attrition not reported Not equal attention control for comparison group
		Plasma glucose Fasting insulin		Short-term weight loss was assessed
2005, Resnicow et al.	RCT	Intervention duration:	No significant difference between group effects.	Strengths:
Atlanta, Georgia	Experimental: high-intensity 20–26 sessions	6 months	6 months: post intervention	Parental component
$n = 147$, mean age 14	Comparison: moderate-intensity 6 sessions from the high-intensity group	Follow-up: 12 months	Moderate intensity	No significant differences at baseline between groups
Age 12–16	Program content:	Measures	Glucose ES: 0.2	Innovative use of pagers to prompt adolescents regarding PA or eating
Mean BMI 32.7	Behavioral skills, nutrition, and exercise.	Height and weight (BMI)	Subgroup analysis	MI via telephone calls well received
Church-based	Motivational interviewing (MI): 4–6 telephone counseling calls (20–30 min).	Body fat percentage (bioimpedance)	Analyzed high vs. low attenders in high-intensity group. High attenders: $\geq$75% of session; low attenders: $\leq$75% of sessions.	Limitations:
	Parental participation: Every other session	Waist and hip circumference	Significant difference in BMI and body fat percentage at 6 months between groups.	Attrition >20%
	Group leaders: exercise physiologist, dietician, and counselor (psychologist or in public health).	BP Fasting: glucose, insulin, and lipids Shuttle test: CV fitness Dietary assessment		Not theory based Comparison group may have received too high a dose of the intervention

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
2005, Jiang et al.	RCT	Intervention duration:	Significant difference between group effects	Strengths:
Beijing, China	Experimental group: home-based intervention	24 months		Parental component
n = 75, mean age 13.2	Control group: usual activity	Follow-up: none	24 months: post intervention	No significant differences at baseline between groups
7th–9th grades	Program content:	Measures	Experimental group:	Innovative approach with study methods (home-based intervention)
41 males, 27 females	Researchers visited home one time per month for 24 months. Assessed home environment and provided information regarding behavior change for diet and physical activity. Use traffic light diet, encourage calorie counting, PA 4 days/week for 20–30 minutes, and decrease sedentary time.	Height	Total cholesterol ES: 0.72	Long duration of study
	Interventionist: pediatricians	Weight	Triglycerides ES: 0.56	Limitations:
Mean BMI 26.6		Blood pressure		Not theory based
Home-based		Total cholesterol		Not equal attention control for comparison group
		Triglycerides		Resource-intensive
2005, Williamson et al.	RCT	Intervention duration:	Significant difference between group effects	Strengths:
Baton Rouge, LA	Experimental group: behavior intervention	6 months: 4 in-person sessions and Internet		Parental component
n = 57, mean age 13.19	Control group: passive health education on healthy nutrition and exercise	Follow-up: 24 months		No significant differences at baseline between groups
Age 11–15	Program content:	Measures		Standardized intervention via internet.
Mean BMI: 36.34	Behavioral skills, nutrition, and exercise.	Height, weight, and DEXA		Innovative use of resources to implement intervention on the Internet

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
Mean BMI percentile: 98.3		24-hour food recall		Limitations:
Presumed clinic-based	Parental participation: parents participated in face-to-face sessions and Internet intervention	Food Frequency Quest		Attrition >20%
	Group leader: registered dietician gave nutrition counseling (weeks 1, 3, 6, and 12)	Weight loss behavior		Not theory based
		Dietary self-efficacy PA social support Children's Eating Attitude Test Satisfaction with life scale Child Depression Index Rosenberg Self-Esteem		
2006, Jelalian et al.	RCT	Intervention duration:	No significant difference between group effects	Strengths:
Rhode Island	Experimental group: cognitive behavioral therapy (CBT) with peer-enhanced adventure therapy (PEAT)	4 months: 16 weekly and 4 monthly sessions.		Parental component
$n = 76$, mean age 14.51	Control group: CBT with additional exercise session (EX)	Follow-up: 10 months		No significant differences at baseline between groups
Age 13–16	Program content:	Measures		Comparison group receive similar opportunity for attention control

(Continued).

TABLE 2
(Continued)

YEAR, AUTHOR, LOCATION, SAMPLE, SETTING, AND TITLE	DESIGN AND INTERVENTION	INTERVENTION PERIOD, FOLLOW-UP, AND ATTRITION	FINDINGS[a] (EFFECT SIZE = ES)	STRENGTHS AND LIMITATIONS
Mean BMI 32.5	Behavioral skills, nutrition, and exercise.	Height and weight		Limitations:
Presumed clinic-based	Parental participation: parallel content to teen	Self-perception profile for adolescents		Not theory based
	Group leaders: doctorate level psychologist	Children's physical self-perception		Attrition >20%
		Social Support Scale for Children and Adolescents		
2007, Park et al.	RCT	Intervention duration:	Significant difference between group effects	Strengths:
Korea	Experimental group: intervention	12 weeks	12 weeks: post intervention	No significant differences at baseline between groups
Convenience sample	Control group: usual activities	Follow-up: none	Experimental group	Attrition <20%
$n = 44$, mean age 14.1	Program content:	Measures	Weight loss ES: 0.46	Limitations:
Age 13–15	Behavioral skills, nutrition, and exercise.	Body composition with bioelectrical impedance.	BMI ES: 0.61	No parental component
All girls	Parental participation: none	Weight and height	Percentage body fat ES: 0.82	Short-term weight loss was assessed
	Group leaders: physical education instructor and trained counselor	Waist circumference	Waist circumference ES: 0.69	Not theory based
School-based		Tanner staging	Systolic BP ES: 0.95	
		3-day dietary recall	Diastolic BP ES: 0.69	
		Blood pressure	LDL cholesterol ES: 0.48	
		Lipid panel, HOMA-IR,	Glucose ES: 1.02	
		Glucose, insulin, HgbA1C	Insulin ES: 0.88	
		CRP, leptin, adiponectin		

Effect size calculated when mean (SD) reported. RCT, Randomized controlled trial; ES, Effect size; BMI, Body mass index; PA, physical activity; DEXA, Dual energy x-ray absorptiometry; BP, Blood pressure; CV, Cardiovascular.

African American, 33.2% Asian American, 6.2% Hispanic, and 3.6% mixed or other (Neumark-Sztainer et al. 2003).

Most studies included female participants; six included only girls (Dewolfe & Jack 1984; Wadden et al. 1990; Neumark-Sztainer et al. 2003; Resnicow et al. 2005; Williamson et al. 2005; Park et al. 2007), seven mostly girls (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Brownell et al. 1983; Mellin et al. 1987; Emes et al. 1990; Gutin et al. 2002; Jelalian et al. 2006), two mostly boys (Saelens et al. 2002; Jiang et al. 2005), and one a mixed sample (Balagopal et al. 2005). Socioeconomic information was obtained in seven studies; two were conducted with adolescents from lower-middle income households (Brownell et al. 1983; Wadden et al. 1990), four from middle-upper income households (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Saelens et al. 2002; Resnicow et al. 2005), and one with adolescents from a wide span of income households (Mellin et al. 1987).

Description of the Interventions

Location and setting: all studies but two (Jiang et al. 2006—China; Park et al. 2007—Korea) were conducted in North America (see Table 2). The setting for the study was not stated in seven reports but was presumed to be a clinic. Four studies were cited as being clinic-based (Mellin et al. 1987; Emes et al. 1990; Gutin et al. 2002; Saelens et al. 2002), three as school-based (Dewolfe & Jack 1984; Neumark-Sztainer et al. 2003; Park et al. 2007), one as church-based (Resnicow et al. 2005), and one as home-based (Jiang et al. 2005). The sample sizes ranged from 15 to 201 (mean 61.3) adolescents per study.

Inclusion criteria.

The criteria for entry into the studies varied, and when reported, included one of the following: (1) at least 10% above average weight for height (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982); (2) weight at least 20% above for height, gender, and age (Brownell et al. 1983; Emes et al. 1990); (3) triceps skin fold >85th percentile for age and sex (Gutin et al. 2002); (4) at least 10 kg > for weight, gender, and age (Wadden et al. 1990); (5) BMI above 20% for the median gender and age (Saelens et al. 2002); (6) >90th BMI percentile (Resnicow et al. 2005); (7) >85th BMI percentile, with at least one obese biological parent (Williamson et al. 2005); (8) greater than 5 lbs overweight (Dewolfe & Jack 1984); (9) >120% of weight for height for Chinese reference (Jiang et al. 2005); (10) 20–80% overweight by BMI (Jelalian et al. 2006); (11) 95th BMI percentile per Korean Pediatric Association (Park et al. 2007); and (12) low levels of physical activity (Neumark-Sztainer et al. 2003).

TABLE 3
Coding for quality assessment

QUALITY ITEM	CODING	SCORE
1. Was the assignment to the treatment groups really random?	Adequate	3
	Partial	2
	Inadequate	1
Random sequence generation	Unknown	0
2. Was the treatment allocation concealed?	Adequate	3
	Inadequate	1
Concealment of randomization	Unknown	0
3. Were the groups similar at baseline regarding the prognostic factors?	Reported	3
Baseline characteristics	Unknown	0
4. Were the eligibility criteria specified?	Adequate	3
	Partial	2
	Inadequate	1
Prestratification	Unknown	0
5. Compliance (dose)	Adequate	3
	Partial	2
	Inadequate	1
	Unknown	0
6. Were the point estimates and measure of variability presented for the primary outcome measure?	Adequate	3
	Partial	2
	Inadequate	1
Results for the primary outcome measure	Unknown	0
7. Did the analysis include an intention-to-treat analysis?	Adequate	3
	Inadequate	0
Intention-to-treat analysis (ITT)	Adequate	3
	Partial	2
	Inadequate	1
8. Dealing with missing values	Unknown	0
	Adequate	3
9. Loss to follow-up	Partial	2
	Inadequate	1
	Unknown	0
10. Use of reliable measures	Adequate	3
	Partial	1
	Unknown	0
11. Attrition <20% throughout the study duration and follow-up	Adequate	3
	Partial	2
	Inadequate	1
	Unknown	0
12. Adequate control group for attention	Adequate	3
	Inadequate	0

TABLE 4
Data extraction form

GENERAL INFORMATION	AUTHOR ARTICLE TITLE SOURCE
Population characteristics and care setting	Target population (describe)
	Inclusion criteria
	Exclusion criteria
	Recruitment procedures used (participation rates, if available)
	Characteristics of participants at intervention commencement
	Age
	Ethnicity
	Class
	Sex
	Setting
	Geographical region
Number of participants in each condition	Condition A Unit of Allocation
	Condition B
	Condition C
	Condition D
Interventions	Focus of intervention (e.g., alcohol only, alcohol and drugs)
	Name of program (s)
	Number of conditions (including control condition)
	Content of intervention package
	Condition A
	Condition B
	Condition C
	Condition D
	Specific theoretical model (e.g., social learning, Bandura)
	Duration of intervention (Total time = no sessions × length of time in minutes)
	Condition A
	Condition B
	Condition C
	Condition D
	Delivery mode of intervention (e.g., lecture, discussion group)
	Condition A
	Condition B
	Condition C
	Condition D
	Program type (e.g., information only, social skills)
	Condition A
	Condition B
	Condition C
	Condition D
	What mediating variables were investigated (if any)
	Primary staff (e.g., teacher, counselor)
	Condition A
	Condition B
	Condition C
	Condition D
	Was special training provided for primary staff? (Describe.)
Outcomes, outcome measures	What was measured at baseline?
	a)
	b)
	c)
	d)
	e)
	What was measured after the intervention?
	a)
	b)
	c)
	d)
	e)
	Who carried out the measurement?
	What was the measurement tool?
	Was/were the tool(s) validated and how?
	How was the validity of self-reported behavior maximized?
	Time interval between first and second measurement:
	Time interval between first and last measurement:
Analysis	Statistical techniques used
	Does technique adjust for confounding?
	Unit of analysis
	Attrition rate (overall rates)
	Was attrition adequately dealt with?
	Number (or %) followed up from each condition
	Condition A
	Condition B
	Condition C
	Condition D
Results	Quantitative results (e.g., estimates of effect size)

	Condition A Mean (*SD*)	Condition B Mean (*SD*)	Condition C Mean (*SD*)	Condition D Mean (*SD*)
Var	*N* =	*n* =	*n* =	*n* =
Pre-test				
Post-test				
Difference				
Var	*N* =	*n* =	*n* =	*n* =
Pre-test				
Post-test				
Difference				
Var	*N* =	*n* =	*n* =	*n* =
Pre-test				
Post-test				
Difference				

(Continued)

TABLE 4
(Continued)

Var	*N* =	*n* =	*n* =	*n* =
Pre-test				
Post-test				
Difference				
Var	*N* =	*n* =	*n* =	*n* =
Pre-test				
Post-test				
Difference				

Interventions.
The interventions were diverse across the studies, with participants primarily meeting weekly (see Table 2). Additional schedules included meeting two times per week, five times per week, six times per week, intermittent face-to-face sessions with supplementary Internet or telephone follow-up, or home visits once per month. All of the interventions provided information regarding healthy eating, nutrition, and behavior modification techniques such as self-monitoring, stimulus control, cue elimination, and attitude restructuring. About half of the studies had physical activity as a component of the intervention (Dewolfe & Jack 1984; Mellin et al. 1987; Emes et al. 1990; Gutin et al. 2002; Neumark-Sztainer et al. 2003; Balagopal et al. 2005; Resnicow et al. 2005; Jelalian et al. 2006; Park et al. 2007).

Parental involvement.
The degree of parental participation varied among the studies, with 13 interventions including a parental component. Two studies had three intervention groups, including a child and a parent together for all sessions, child and parent separate for all sessions, and child alone for all sessions (Brownell et al. 1983; Wadden et al. 1990). Coates and colleagues (1982) completed a study with teens in one group, and with parents and teens in a comparison group. One study included a weekly parental program (Coates, Killen et al. 1982). One study included two parental sessions (Mellin et al. 1987). One study included one parental session (Dewolfe & Jack 1984). Balagopal and colleagues (2005) reported inviting parents or other family members to attend a weekly monitored exercise session. Their intervention was based on "SHAPEDOWN," which includes two parental sessions, but the content of the parental sessions was not reported in the article. Investigators for two studies sent material by mail to encourage parents and teach them how to help their children change behavior (Saelens et al. 2002; Neumark-Sztainer et al. 2003). In one study, parents were invited to attend every other session with their daughters (Resnicow et al. 2005). One study was based on family methods by Epstein, and included parents utilizing Web-based materials, an invitation to be involved in mutual problem solving and behavioral contracting and to attend four face-to-face sessions with their daughters (Williamson et al. 2005). One study included a parent group that met when the teens met but not together (Jelalian et al. 2006). One study was home based and involved the family (Jiang et al. 2005).

Outcomes
Similar outcome variables were used; investigators in 11 studies reported measurement of weight. Weight as BMI or BMI percentile was reported in 11 studies (see Table 1). In the remaining studies, weight, relative weight, percentage overweight, or percentage body fat was reported. Investigators in three studies measured psychological variables (Mellin et al. 1987; Wadden et al. 1990; Williamson et al. 2005), but none appeared to include an intervention component that directly affected the psychological variables. Williamson and colleagues used psychological measures as predictors of subsequent weight loss.

Findings of significant differences between the groups were identified in seven studies (see Table 1). Of these, two interventions had a comparison group with adequate attention control (Brownell et al. 1983; Williamson et al. 2006), with the other five comparison groups receiving a no attention control intervention. In two studies, a comparison between the groups was not reported. In six studies in which no between-group differences were found, each intervention group received at least one component to improve lifestyle choices of physical activity, nutrition, and behavior modification. One study with a comparison group that received no or minimal attention did not have significant between-group effects (Neumark-Sztainer et al. 2003). Outcome variables with significant between-group findings included measures of weight, blood pressure, cholesterol, body composition, BMI, nutrition, and behavioral skill use.

Short-term outcomes were measured in all studies. When long-term outcomes were measured, most participants returned to preintervention weight.

Major Strengths of the Studies
Intervention strengths were relatively consistent among the studies. All studies were RCTs, which is the strongest design for establishing a cause and effect relationship between treatment and outcome variables. All investigators assessed measures pre- and post intervention, which is important to assess the baseline differences between the groups and identify intervention effects. About one-third of the interventions included manualized protocols, increasing the ability to replicate the intervention and facilitate translation of the interventions into clinical practice. For example, one

study had an Internet design, which could be easily replicated; 13 studies included a parent, a strategy that has been shown to enhance intervention outcomes. The majority of instruments and measures used had an established validity and an adequate reliability.

Individual strengths of the studies varied. One multisite study had similar outcomes at all four study sites (Mellin et al. 1987). Two studies had qualitative as well as quantitative data plans, thereby increasing the feasibility and acceptance of the intervention (Neumark-Sztainer et al. 2003; Resnicow et al. 2005). Innovation was apparent in four studies, with utilization of phone calls for repeated follow-up (Saelens et al. 2002), an Internet-based intervention with four face-to-face sessions (Williamson et al. 2005), a home-based intervention to address the environmental influences (Jiang et al. 2005), motivational interviewing for individual counseling (Resnicow et al. 2005), and pagers to prompt dietary and physical activity behaviors (Resnicow et al. 2005).

Major Limitations of Studies

A major limitation in most studies was not including outcome measures related to all program components. For example, a weight-related outcome was measured in all studies, but physical activity levels, dietary intake, or the use of behavioral skills was measured in only a few. Interpretation of the findings is thus limited because of not understanding how each component of the intervention affected participants' daily lives or the mediating effects of the intervention.

Intervention limitations were relatively consistent among the studies. A major limitation in the nine studies was the lack of a comparison group that received equal attention to the intervention group. The purpose of an attention control group is to account for rival hypotheses that could cause changes in the dependent variable other than those in the intervention (Fogg & Gross 2000). Three studies had the same intervention component for the adolescents, with the independent variable being parent participation in the comparison groups (Coates, Killen et al. 1982; Brownell et al. 1983; Wadden et al. 1990). Two studies that did not indicate significant between-group findings had an active weight modification component in the intervention and comparison groups (Resnicow et al. 2005; Jelalian et al. 2006).

Most studies had small sample sizes; eight had sample sizes less than 50, thereby decreasing the ability to generate significant findings because of insufficient statistical power. Attrition rates were >20% in seven studies, which threatens the internal validity of the findings. The external validity was limited in all studies because of the use of convenient homogenous samples. Integrity and fidelity measures of the interventions were not completed, limiting an understanding of the dose response and whether the protocol was implemented as intended.

A major limitation of the studies reviewed was the lack of a theoretical framework to guide interventions. This limits the assessment of variables that might have mediated effects of the interventions, not allowing for empirical explanations for how the interventions worked. One study indicated the use of a theoretical framework, Social Cognitive Theory (Neumark-Sztainer et al. 2003), but the use of the theory was limited, with only some of the variables from the theory being measured, and no discussion of concepts as mediating factors in the behavioral change process.

Two levels of the ecological model were included in studies—individual and parental. Additional contextual factors such as built environment, community, or media were not addressed.

DISCUSSION

Because of the lack of consistency in methods and rigor concerning the studies in this systematic review, the evidence is not clear about the best multicomponent program for addressing obesity in middle adolescents. Of the seven studies with significant findings, six did not have a comparison group with equal attention to the intervention group. Therefore, it can only be concluded that a multicomponent intervention is successful in improving weight or cardiovascular risk factors when compared to an unequal attention comparison group. Six studies not indicating significant between-group findings had an active weight modification component in the comparison group. This might indicate that varying interventions are effective because five of the six studies had significant pre- and postchanges when the intervention and comparison groups were combined (Coates, Jeffery et al. 1982; Coates, Killen et al. 1982; Emes et al. 1990; Wadden et al. 1990; Jelalian et al. 2006). Intervention content was similar among studies including healthy eating, physical activity, and behavior modification. The majority of studies had a parental component. The length of time or program intensity did not allow predicting the program success in that the longer programs or having more sessions did not increase the likelihood that the program achieved statistically significant results. However, the success of an intervention was associated with the dose of the intervention received. Generally, participants attending more sessions with greater parental participation lost more weight than did those attending fewer sessions with less parental participation. No clear pattern for efficacy was noted in regard to ethnicity. All three of the studies that involved caloric restrictions were efficacious.

Two studies indicated either a telephone or an Internet intervention with a limited number of face-to-face sessions. Despite treatment effects being less effective in these two studies than in other more resource-intensive programs, these approaches are feasible methods that can be implemented with a comparatively larger number of overweight adolescents and their parents.

Several limitations exist in this review. Only manuscripts published in English were included, a systematic review was completed rather than a meta-analysis because of inconsistency in the variables measured, and findings not being weighted according to the methodological rigor.

IMPLICATIONS FOR CLINICAL PRACTICE

Treating overweight adolescents is challenging. Concern for labeling teens as overweight exists during this developmental stage of identity development. The use of multicomponent interventions for the treatment of obesity is well supported in the literature (Jelalian & Saelens 1999; Boon & Clydesdale 2005; Summerbell et al. 2005; American Dietetic Association, 2006; Flynn et al. 2006; Stice et al. 2006). Therefore, based on evidence from studies, clinicians should implement multicomponent interventions that involve the use of nutrition education, physical activity with monitored experience, and behavior modification. Additionally, clinicians should assess the levels of anxiety and depressive symptoms as well as self-esteem in overweight teens because prior evidence has indicated that a strong association between obesity and negative mental health outcomes exists (Melnyk et al. 2006). A recent study by Melnyk and colleagues (2006) indicated that higher levels of depressive and anxiety symptoms and lower self-esteem in overweight teens were associated with less healthy beliefs about their ability to engage in a healthy lifestyle. Teens who perceived healthy lifestyles as more difficult also had less healthy attitudes and reported less healthy choices and behaviors. Therefore, including a strong cognitive behavioral skill building component into clinical interventions with overweight teens might be the key in boosting their confidence about being able to engage in healthy behaviors and should result in healthier choices and lifestyle behaviors.

Home environments strongly influence lifestyle choices of children and teens (Lindsay et al. 2006). As such, treatment programs for overweight adolescents should ideally include a parent component. In a systematic review of family involvement in weight control, McLean and colleagues found that parental involvement is associated with weight loss in children (McLean et al. 2003). Creating programs to improve parenting behaviors pertinent to childhood obesity is a highly promising strategy (Lindsay et al. 2006).

IMPLICATIONS FOR RESEARCH

Research with overweight teens or those at risk for overweight should include a comparison group without an active component for changing healthy lifestyles. This will allow identifying specific components of interventions that are most efficacious. Additionally, developing and testing theory-based interventions and measuring mediating variables, which can enlighten researchers about the processes through which the interventions work, are important. Assessing moderating variables (e.g., socioeconomic status, level of depressive symptoms) also would be helpful in determining for which adolescents the interventions work best. Including measures for the active components of the intervention, such as physical activity, nutrition, and behavioral skill use, can clarify the mediating role of each component. Furthermore, adding a cognitive behavioral skill building/mental health component to the interventions with overweight teens also might potentiate the efficacy of the intervention programs because recent research has indicated that how overweight teens think is related to their emotions and how they behave (Melnyk et al. 2006).

The intervention programs thus far have primarily been focused on individual-level interventions with varying degrees of parental participation. Over time, interventions with adolescents have become less efficacious at reducing weight or decreasing BMI. This may be because of the "obesogenic" environment in which we live. Despite not knowing the exact mechanism for the increase in the prevalence of obesity, several environmental factors seem to be contributing. For example, eating more calorie-dense foods and eating more frequently at restaurants coupled with more time in sedentary activities are socially acceptable changes that have occurred over the past several decades. Research focused on multiple levels of the ecological model might enhance the understanding of the contributions of the many influences on dietary and physical activity habits. Additionally, more research is needed with culturally diverse samples of adolescents.

CONCLUSIONS

Obesity in adolescence is a significant public-health concern. A structured program addressing nutrition, physical activity, and behavioral skills appears to be efficacious in reducing weight and cardiovascular risk factors. Primarily, interventions have included the overweight person, and sometimes, the parents. In the past few years, more research has addressed the multiple levels of the ecological model. Further research addressing all levels of the ecological model might help in illuminating the effect of the environment on behavior change in adolescents. Because studies have not shown long-term sustainable effects of

interventions, Summerbell and colleagues suggest, "Perhaps outcomes will only be achieved through a multifactorial theoretical approach that considers the impact of system, environment, and organizational issues, as well as the need to consider and address individual and group behavior change" (Summerbell et al. 2005).

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