Treatment Interventions for Early Childhood Obesity: A Systematic Review

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ABSTRACT

CONTEXT: With 25% of preschool-age children in the United States being overweight or obese, effective interventions for these children would have significant public health implications. Randomized trials targeting this age group have been performed since the last systematic review.

OBJECTIVE: To systematically review the literature on treatment interventions for overweight or obesity in preschool-age children.

DATA SOURCES: Medline (1948–July 2014), the Cochrane Central Registry (1991–July 2014), CINAHL (1990–July2014), and PAS abstracts (2000–2014).

STUDY SELECTION: Inclusion criteria were children aged 0 to 6 in the study and adiposity as an outcome. Exclusions were having normal-weight children in the trial and not having a comparison group.

DATA EXTRACTION: Data were extracted independently by 2 authors using a template.

RESULTS: The initial search yielded 1981 results, narrowed to 289 abstracts after initial review. Further analysis and cross-referencing led to the selection of 6 randomized controlled trials representing 1222 children. Two studies used systems changes and motivational interviewing and showed no significant effect on adiposity. Two studies used an intensive, multidisciplinary approach over 6 months and demonstrated significant decreases in adiposity. One study tested parental coaching and showed a significant reduction in adiposity at 6 months. One study used education on a dairy-rich diet and showed a possible effect on adiposity.

LIMITATIONS: The study designs were too heterogeneous for meta-analysis; few ethnic minority subjects were included.

CONCLUSIONS: Multidisciplinary, intensive interventions have some evidence of efficacy in reducing adiposity in preschool children.

KEYWORDS: body mass index; child; health behavior; health promotion; obesity; overweight; preschool

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WHAT THIS SYSTEMATIC REVIEW ADDS

- This is the first systematic review of treatment interventions for obese 2- to 5-year-olds.
- Multidisciplinary, intensive approaches to treatment have the most evidence of efficacy.
- Evidence testing treatment interventions in minority populations is limited.

HOW TO USE THIS SYSTEMATIC REVIEW

- Investigation into the degree of intensity required for effective treatment is warranted.
- Treatment programs need evaluation in high-risk groups, particularly racial and ethnic minority groups.
- There is evidence supporting stage 3 interventions of obesity treatment; there is little evidence supporting the other stages in this age group.

DESPITE SOMEWHAT STABILIZED childhood obesity rates in the United States, 30% of children remain overweight or obese, with racial and ethnic minorities at higher risk.[1] These trends are evident even in the youngest children, with 1 out of 10 children under the age of 6 being obese.[1] Although the 2- to 5-year-old age group experienced a slight decline in overweight prevalence (5.5%) from 2003–2004 through 2011–2012, all other age groups, including 0- to 2-year-olds, have shown no significant decreases.

Data show that early childhood weight status tracks into adolescence and adulthood,[2,3] suggesting that successful earlier intervention and prevention may potentially be more clinically effective and cost-effective. Positive health behaviors developed early in life can also track into adolescence and adulthood. Understanding what interventions are effective among overweight and obese children aged 6 and under is critical to preventing overweight in later years and the subsequent associated complications.

Synthesizing and assessing the research in childhood obesity interventions among children aged 6 and under would provide critical direction for future programs and policies. However, recent systematic reviews of interventions

in childhood obesity have focused on school-age and adolescent children.[4–6] Reviews of treatment interventions among younger children have included both normal and overweight children reducing the ability to identify effectiveness of treatment interventions exclusively as opposed to primary prevention[7] or were completed before more recent clinical trials targeting this age group.[8,9]

In this systematic review, we attempted to address this question: in children aged 0 to 6 years who are overweight or obese, what behavioral or clinical interventions have been shown to be effective in reducing adiposity using a clinical trial design? In asking this question, we aimed to characterize commonalities to success so as to best inform this rapidly developing area of research. Innovative aspects of this review include a focus on treatment interventions for overweight and obese children and an examination of intervention effectiveness among children 6 years and younger, a critical population for clinical and cost-effective interventions.

METHODS

REVIEW PROTOCOL

A detailed protocol was developed and is available by request from the corresponding author. A priori inclusion criteria were studies that enrolled children aged 0 to 6, included a measure of adiposity as an outcome, and had a specific strategy for addressing children aged 0 to 6 if other ages were included. Inclusion of normal-weight children was an exclusion criterion, as we chose to focus on intervention rather than primary prevention. We used 3 accepted definitions for overweight or obesity to evaluate this exclusion criterion: the US Centers for Disease Control and Prevention,[10] the World Health Organization,[11] or the International Obesity Task Force.[12] A search of Medline (1946–July 2014), the Cochrane Central Registry (1991–July 2014), CINAHL (1990–July2014), and PAS abstracts (2000–2014) was completed in July 2014. For the Medline search, terms used in the search were "obesity," "overweight," combined with "OR," then the filters of children (aged 0–18 years) and clinical trial applied to the results. Results from the initial search were cross-referenced and liberally screened by title and abstract to ensure the study focused on children and overweight or obesity. Any lack of clarity on the study's inclusion criteria or outcomes at this point led to a full-text review. For the second round, abstracts—and, as necessary, full articles—were screened using the inclusion and exclusion criteria by 2 authors independently (BF, PP). A hand search of the reference lists of all selected full text articles was done by 2 authors independently (BF, PP). Only clinical trials, and not observational studies, were included in this review.

PRIMARY OUTCOME

The primary outcome measure was a measure of adiposity in participants (children) using the longest available time point after the start of the intervention; no minimum follow-up was a priori set. Acceptable outcome measures for adiposity a priori included body mass index (BMI), BMI percentile, or some iteration of percentage overweight or obese using height, weight, and waist circumference.

SECONDARY OUTCOMES

We collected secondary outcome data on any measure of behavioral change, measures of nutritional intake, activity, or feeding patterns in order to help elucidate potential mechanisms.

DATA COLLECTION

Data were collected using a standardized form that was piloted between 2 authors (BF, JF). The pilot process involved both authors extracting data from previously identified obesity intervention manuscripts and cross-comparing extracted data on intervention and outcomes; the only data process changed was including multiple measures of adiposity within a study. The data were extracted independently by 2 authors (BF, JF). Authors of primary studies were contacted as needed for clarification of results. For each study, we extracted data on the study date and duration; number, demographics, and age of participants enrolled and completed in each group; intervention methods; setting; exclusion criteria; the primary and secondary outcomes defined by this review and when data were collected.

HETEROGENEITY AND BIAS ASSESSMENT

For methodologic heterogeneity, we used a qualitative approach, with 2 authors (BF, ES) examining the studies for similarities in intervention, comparison, and population. We planned to use the I^2 statistic to test for statistical heterogeneity if there was sufficient methodologic similarity to combine studies in a meta-analysis.

Using the criteria proposed by the Cochrane group, random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective reporting were assessed.[13] These were graded for each individual study as low, high, or unclear risk of bias by 2 authors (BF, PP) independently. If an article had a high risk of bias, it was discussed for inclusion status. To assess bias across studies, we planned to use a funnel plot and assess for asymmetry.

RESULTS

SEARCH RESULTS

The initial search yielded 1981 results that were narrowed down to 289 abstracts after initial review of title and abstract for inclusion criteria (done by BF, JF, PP) (Figure). Further analysis of full articles and cross-referencing led to the selection of the 6 studies included in this review (BF, JF); any conflicts were resolved via discussion. Of the 289 articles, 81 were excluded as a result of an inability to analyze the 0- to 6-year-old age group independently of other age groups. For example, most studies only included 5-year-olds on the lower age range (eg, 5- to 11-year-olds), with very few 5-year-olds actually

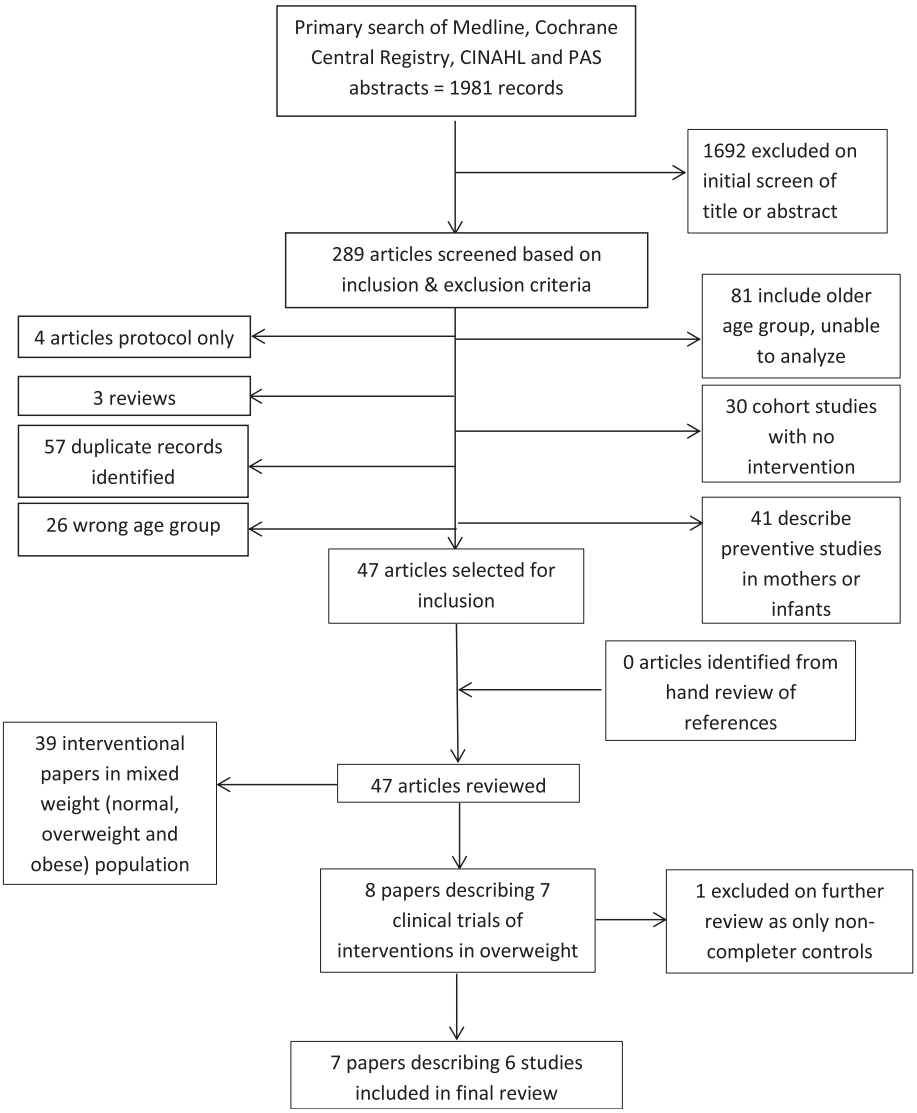

Figure. *Flow chart of search process.*

enrolled. Additionally, 37 studies were excluded because they included normal-weight children in the intervention and for this analysis were deemed preventive in nature. Recent systematic reviews and the included articles were analyzed and cross-referenced for additional studies. Our final analysis revealed 7 articles representing 6 studies (Table 1) with a total of 1222 children enrolled.[14–19] For the 2 articles reporting on a single study, we used the initial publication[17] as the main reference for analysis because the second publication reporting follow-up data did not present data by treatment group.[20]

Study Designs and Settings

The 6 studies all randomized participants to a control or intervention condition that ran simultaneously; basic design characteristics are presented in Table 1. All studies used exclusion criteria of having a chronic medical condition or not obtaining clearance from their pediatrician to participate. Of the 3 studies conducted in the United States, one enrolled a significant number of nonwhite participants (43.3% of the subjects),[18] with the others targeting a majority white population (83% in both studies).[16,17] Similarly, 8% to 11% of participants in the latter 2 studies[16,17] were from "low-income" families, defined as <$20,000[16] or <$50,000,[17] while in the former study[18] that figure was 29%, defined as <$50,000.[18] Two non-US studies did not provide demographics[14,15]; one Dutch study enrolled mostly children of mid–high to highly educated mothers (66.7%), and the children were primarily native Dutch (83.1%).[19]

Control Conditions

All the studies randomized subjects to a control condition that ranged from usual care with their current provider[18] up to ten 60-minute educational sessions with a separate provider with special training in providing education (Table 1).[16]

Interventions and Outcomes

There was a wide range of content and intensity of the interventions across studies. The adiposity outcomes, the primary focus of this review, were measured at the end of

Table 1. Summary of Included Studies' Design and Context for All Randomized Controlled Trials (n = 6)

Study	Participant Age	Inclusion Criteria	Intervention Condition (Provider, No. of Sessions)	Time Intensity	Control Condition (Provider, No. of Sessions)	Sample Size
Bocca 2012, Netherlands[14]	3–5 y	Overweight or obese children with BMI *z* score >1.1	Diet advice (dietician, 6), physical activity sessions (physiotherapist, 12), group behavioral counseling sessions (psychologist, 6)	27 h over 4 mo	Healthy eating behaviors, encouraged activity (pediatrician, 3)	32 IC, 25 CC
Kelishadi 2009, Iran[15]	5.6 ± 0.5 y	BMI ≥ age- or sex-specific 95th percentile	Healthy lifestyle education plus diet information (pediatrician, dietician, 6); DR group: >800 mg Ca/d; ER group: restricted calories	6 monthly sessions for IC and CC (unclear time per session)	Healthy lifestyle education (pediatrician, dietician); no specific diet advice	36 DR, 31 ER, 32 CC
Quattrin 2012, USA[16]	2–5 y	BMI ≥85th percentile for age and gender *and* 1 parent with BMI ≥27	Diet, physical, and sedentary activities education with phone-based coaching between meetings (PEAs, 10)	10 h over 6 mo in person, 8 phone calls	Same educational sessions without in-person coach after meetings	46 IC, 50 CC
Stark 2011, USA[17]	2–5 y	≥95th percentile BMI, not more than 100% above the mean BMI and a parent with BMI ≥25	Diet, physical activity, and behavioral management; mixed group and individual sessions (psychologist, 18); 12 wk supply of vegetables provided	27 h over 6 mo in clinic and in home	Healthy diet, physical activity, decrease screen time (pediatrician, 1); brochure given	8 IC, 10 CC
Taveras 2011, USA[18]	2–6.9 y	BMI ≥95th percentile or >85th percentile and 1 parent overweight	Motivational interviewing and education focused on: TV, sugar sweetened beverages and fast food (PNP, 4); also enhanced EMR	4 clinic visits (25 min each), 4 phone calls (15 min each) over 1 y	Standard of care in the practice (pediatrician)	253 IC, 192 CC
Van Grieken 2013, Netherlands[19]	5 y	Overweight but not obese children	Motivational interviewing on 1) playing outdoors, 2) eating breakfast, 3) reducing sweet drinks, 4) watching TV, computer gaming (physician–nurse team, 4)	4 visits in clinic over 1 y (unclear time per visit)	General information on a healthy lifestyle during the well-child visit (physician-nurse team)	277 IC, 230 CC

BMI indicates body mass index; DR, dairy rich; ER, energy restricted; IC, intervention condition; CC, control condition; PEA, practice enhancement assistant (person embedded in practice with a bachelor's or master's degree in psychology, nutrition, or exercise science); PNP, pediatric nurse practitioner; and EMR, electronic medical record.

the intervention period using the baseline assessment as comparison. Four of the 6 studies also included an additional postintervention follow-up time point.[14,15,17,19] Given the heterogeneity in both design and especially in the intervention, we did not conduct a meta-analysis of the outcome data. Instead, we provide a qualitative synthesis of the articles grouped by design similarities. Two studies attempted to leverage existing clinic resources and randomized by clinic or clinician, 2 studies had intensive, multidisciplinary interventions, 1 study evaluated the effect of personalized coaching versus education, and 1 study evaluated different dietary education prescriptions.

Two studies used an approach building on current capacity using the current clinical context and providers to implement most of the intervention.[18,19] The study by Taveras et al[18] was a cluster-randomized trial with individual practices assigned to intervention or control. Intervention practices received updates to their electronic medical record, staff training, health promotion in waiting rooms, educational handouts, and resource lists for patients. Motivational interviewing around obesity-related health behaviors was delivered by trained pediatric nurse practitioners, with 4 in-person visits designed to occur over the first year; notably, only 56% of the participants had 2 or more interactions (including phone calls). They did not find a significant difference in change in BMI at 1 year between intervention and control participants (Table 2); a post hoc analysis showed significant effects on BMI in female subjects ($P = .03$) and those in households with incomes less than $50,000 ($P = .01$). Van Grieken et al[19] randomized by clinical team (n = 44 physician–nurse teams, 72% pediatricians) within clinic sites (n = 9). All clinical sites, and therefore teams, received some systems-based intervention to improve identification and tracking of weight status. Intervention teams received motivational interviewing training and could provide up to 4 total visits over the first year of the program; 76.7% of participants received 2 visits, and 30.6% received all 4 visits. They did not show significant decreases in overall BMI between groups (Table 2); they did demonstrate a difference for only mildly overweight individuals in their subanalysis ($P = .05$).

Two studies had designs similar in using intensive interventions and fairly low levels of interaction with controls.[14,17] Stark et al[17] randomized parent–child dyads to intervention or control. They provided intervention participants with dietary education, physical activity education, and coaching on physical activity and general behavioral management in both a group setting and via an in-home intervention in a 2-stage process with initially 12 weeks of weekly interactions and then 12 weeks of every-other-week interactions. Professionals also used in-home assessments to help families identify play areas and reducing high-calorie, low-nutrient foods from their specific home environment. They demonstrated a sustained effect on BMI at 12 months with a between-group difference of -0.77 kg/m^2 (95% confidence interval -1.26, -0.27). In a similar design, parent–child dyads randomized to the intervention condition in Bocca et al[14] received education on diet, physical activity, and behavioral counseling. Diet education was provided in six 30-minute sessions with a dietician; a physiotherapist conducted twelve 60-minute sessions of group physical activity; and a psychologist conducted six 120-minute group behavioral therapy sessions focusing on role modeling and behavior change appropriate for the age group. Bocca et al[14] showed significant changes in BMI at 4 months with a decrease of -1.2 kg/m^2 (95% confidence interval -1.50, -0.81) in the intervention compared to -0.6 kg/m^2 (95% confidence interval -1.04, -0.19) in controls, and at 12 months in the intervention compared to controls ($P = .03$; Table 2).

The study of Quattrin et al[16] differed as it provided education to both intervention and control while testing the effect of personalized coaching around behavior. All parent–child dyads received ten 60-minute educational sessions on diet, physical activity, and sedentary activities. All parents were contacted 8 times over the phone to follow-up on the educational sessions. Only participants randomized to the intervention received teaching on behavioral techniques in a group setting and then a 1:1 coach to discuss specific objectives and review progress after these sessions. They showed significant reductions in percentage over median BMI from 30.6% ± 9.7% at baseline to 24.2% ± 10.1% at 6 months compared to the control group of 30.5% ± 9.3% to 28.3% ± 9.5% ($P < .0021$).

Kelishadi et al[15] provided all participants with 6 monthly educational sessions led by a pediatrician and dietician with randomization of children into 1 of 3 dietary recommendations: restricted caloric intake, dairy-rich diet, or usual care of nonspecific healthy-diet education. A specific diet was not provided by the study, and no other visits were prescribed. They found significant reductions in mean BMI z scores across all groups compared to baseline after the end of the intervention at 6 months (dairy rich: -0.6, $P = .01$; energy restricted: -0.6, $P = .01$; control: -0.5, $P = .01$) with no significant difference between groups; they reported a significant mean change from baseline to 6 months in waist circumference (dairy rich: -2.0cm; energy restricted: -2.5cm; control: -1.7) with a significant difference across all groups ($P = .01$). At 36 months, researchers reported an increase in BMI z score between baseline and follow-up in the energy-restricted (mean change 0.7, SD = 0.01) and control groups (mean change 0.6, SD = 0.02) with a smaller increase in the dairy-rich group (mean change -0.1, SD = 0.004, $P = .001$); similar data of a smaller increase in the dairy-rich group were presented for the waist circumference outcome (Table 2).

Secondary Outcomes

Although all of the study designs targeted diet and activity behaviors, 2 did not report on the secondary outcomes.[16,19] Of the 2 intensive interventions, Bocca et al[14] found no difference in activity as measured by a pedometer and energy intake measured by a food diary, and Stark et al[17] found no difference in activity as measured by an actigraph but did find decreased caloric intake as assessed via serial 24-hour dietary recalls. Kelishadi et al[15] found no difference in energy expenditure measured via a questionnaire reportedly validated against an accelerometer and no

Table 2. Summary of Outcomes Across Included Studies Using the Longest Time Point for Each Study

Study	Primary Outcomes	Time Point	Outcome at End of Study			Secondary Outcomes (Diet and Activity Assessments)
			Intervention Condition	Control Condition	Difference Between Conditions	
Bocca 2012, Netherlands[14]	BMI	12 mo	−1.0 kg/m^2 (95% CI −1.52, −0.47)	0.0 kg/m^2 (95% CI −0.67, 0.62)	$P = .03$	No difference in activity (steps per day) at 12 mo, $P = .39$; no difference in energy intake (calories) at 12 mo, $P = .87$
	WC *z* score	12 mo	−0.4 (95% CI −0.57, −0.14)	−0.3 (95% CI −0.61, −0.01)	$P = .01$	
	BMI *z* score	12 mo	−0.6 (95% CI −0.82, −0.44)	−0.3 (95% CI −0.49, −0.05)	$P = .02$	
Kelishadi 2009, Iran[15]	BMI *z* score	36 mo	Change from baseline, mean (SD) DR −0.1 (0.004)	ER: 0.7 (0.01); control: 0.6 (0.02)	$P = .001$	Mean energy intake lower in ER group at 6 mo, no difference at 36 mo; energy expenditure reported as NS difference at all time points
	WC		Change from baseline, mean (SD) DR 4.1 (0.3)	ER: 4.8 (0.2); control: 5.2 (0.4)	$P = .04$	
Quattrin 2012, USA[16]	Percentage over median BMI	6 mo	From 30.6% ± 9.7, to 24.2% ± 10.1	From 30.5% ± 9.3 to 28.3% ± 9.5	$P < .0021$	None reported
Stark 2011, USA[17]	BMI *z* score	12 mo	Change from baseline, mean (SD) −0.37 (0.41)	Change from baseline, mean (SD) 0.40 (0.49)	−0.77, (95% CI −1.26, −0.27)	Difference at 12 mo for calorie intake (kcal): −525 (95% CI −811, −240); average of 20 min vigorous activity, 59–75 min moderate activity per day across time points, NS between groups
Taveras 2011, USA[18]	BMI	12 mo	From baseline, mean (SE): 0.31 (0.09)	From baseline, mean (SE): 0.49 (0.10)	−0.21 kg/m^2 (95% CI −0.50, 0.07)	NS difference at 12 mo for activity (h/d); soda (servings/d); fruit/vegetable intake (servings/d) or fast food (servings/wk); TV (h/d): −0.36 (95% CI −0.64, −0.09), $P = .01$
	BMI *z* score	12 mo	NA	NA	−0.05 (95% CI −0.14, 0.04)	
Van Grieken 2013, Netherlands[19]	BMI	2 y	Change from baseline, mean (SD) 1.37 (1.53)	Change from baseline, mean (SD) 1.44 (1.71)	−0.16 kg/m^2 (95% CI −0.6, 0.27)	None reported
	WC	2 y	Change from baseline, mean (SD) 7.20 (5.49)	Change from baseline, mean (SD) 7.33 (5.30)	−0.16 cm (95% CI −1.10, 0.78)	

BMI indicates body mass index; CI, confidence interval; WC, waist circumference; DR, dairy rich; ER, energy restricted; and NA, not applicable.

difference in mean energy intake at 36 months as assessed via a 3-day food diary.

RISK OF BIAS

All of the studies used either a form of computerized randomization or a random numbers table and method of allocation concealment that we considered to be low risk (Table 3). Three studies were determined to be at high or unclear risk for blinding of personnel.[14,16,18] Only 2 of the studies documented blinding to treatment status when obtaining outcome measures.[17,19] For the unblinded studies, given the fact that the primary measures were adiposity indices, there is a low threat to validity given the objective nature of the measurement. Although there were certain components of the individual studies that contained a high or unclear risk of bias, given the objective outcome, low selective reporting, suitable random sequence generation, and allocation concealment, the threat to validity from these potential biases was judged to be low. Given the heterogeneity in reported outcomes (BMI vs BMI z score vs percentage over median) and the small number of studies reporting the same outcome, we were not able to utilize a funnel plot to assess for potential publication bias.

DISCUSSION

In this systematic review of treatment interventions for obesity in early childhood, the more intensive multidisciplinary studies[14,17] demonstrated significant reductions in adiposity measures compared to usual care, while negative results were seen in 2 large studies done using systems-based interventions along with motivational interviewing.[18,19] The other study that demonstrated a significant change in adiposity measure[16] differed from the more intensive studies in 2 ways. First, they primarily tested only 1 variable: the role of a parent coach. Second, they had a much more similar control group in terms of intensity, in contrast to the other 2 studies whose usual care conditions were very low intensity.[14,17]

The significant effects seen in the 2 intensive multidisciplinary interventions[14,17] highlight the need for intense interventions but raises the issue of feasibility. Intensive studies may work to reduce adiposity, at least in the short term, but they would be challenging for most communities to implement. More scalable interventions like those proposed by Taveras et al[18] and van Grieken et al[19] demonstrate that for interventional purposes, that degree of intensity may not be enough. The study by Quattrin et al[16] is arguably somewhere in between the others in intensity of the intervention and places additional evidence behind the idea of using some form of coaching or mentoring, as suggested by other studies.[21–23] Indeed, the primary difference between Quattrin et al and the 2 motivational interviewing studies, after taking into account the difference in control conditions, can be viewed as frequency of contact as Quattrin et al had 8 coaching interactions over 6 months versus the 4 to 7 interactions over a year in the others, with many having only 2 interactions.[18,19] Notably, data from Quattrin et al on longer-term, follow-up outcomes published after this review was completed demonstrate a sustained effect of the intervention at 12 months postintervention.[24] An exploration of the frequency of contact needed to create and sustain behavioral change around diet and activity in this age group would assist future study and program designs.

The lack of an effect on the intermediate outcome of physical activity in 3 studies that showed some effect on adiposity[14,15,17] seems to argue against focusing on that aspect in this age group. Outcomes from trials in older children have also failed to demonstrate a consistent or sustained effect of interventions focused on activity alone.[25] The intermediate outcome of energy intake had mixed results, with 1 study showing a significant difference in the intervention group and 2 failing to show a difference; the heterogeneity in assessments, known challenges to those methods and a lack of direct comparisons in this age group limits any conclusions.

Prior systematic reviews examining obesity interventions in older children have highlighted that combined interventions that have a behavioral component are most effective.[25,26] These were completed before the publication of the studies included in this review, but the general finding is consistent regarding what works—that is, focusing on both diet and physical activity with a behavioral component. Also consistent with the findings here is that more intense interventions in older children tend to demonstrate greater efficacy in reducing adiposity, though the exact level of intensity is not established.[27,28] Motivational interviewing has been found to be effective in promoting weight loss in adults,[29] and this approach has been explored recently in older children, with results thus far showing mixed results.[30–32]

We also examined how the US expert committee recommendations[33] align with the evidence from this review in

Table 3. Assessment of Bias for Included Studies

Study	Random Sequence Generation	Allocation Concealment	Blinding of Participants and Personnel	Blinding of Outcomes	Incomplete Outcome Data	Selective Reporting
Taveras 2011[18]	Low	Low	High	Unclear	Low	Low
Boca 2012[14]	Low	Low	Unclear	Unclear	Low	Low
Kelishadi 2009[15]	Low	Low	Low	Unclear	Low	Low
Quattrin 2012[16]	Low	Low	High	Unclear	Low	Low
Van Grieken 2013[19]	Low	Low	Low	Low	Low	Low
Stark 2011[17]	Low	Low	Low	Low	Low	Low

order to inform current practice. The expert recommendations put forth a staged approach: stage 1 or prevention plus, which constitutes engaging in healthy lifestyle eating and activity habits; stage 2 or structured weight management, which includes a structured approach to diet, structured activity and increased monitoring (monthly visits); stage 3 or comprehensive multidisciplinary intervention, which has similar goals but with more monitoring (weekly visits initially) and includes structured behavioral intervention (with a behavioral counselor), a dietician, and an activity specialist; and finally stage 4 or tertiary care intervention, which entails a program addressing the above as well as consideration of medications, severe dietary restrictions, or surgical intervention.[33] Four studies approximated a stage 1 intervention for controls[14,17–19]; only Bocca et al[14] demonstrated any impact on BMI, and that effect was seen at the 4-month follow-up and not the 12-month postintervention time point. The other 3 studies showed an increase in the adiposity measure. None of the arms truly approximated step 2 of the recommendations; the control arm of Quattrin et al[16] and both arms of Kelishadi et al[15] approximate at least the monthly interaction component, and all 3 arms showed some reduction in adiposity measure at 6 months. The intervention arms of Stark et al[17] and Bocca et al[14] approximate step 3 of the recommendations, and both arms showed a significant reduction in their adiposity measures. Therefore, the evidence to date has the strongest support for step 3 interventions. There is no evidence to support step 1 interventions having a significant effect in this age group at this time, and there is an absence of evidence around step 2 for this age group.

We did not include studies that included normal-weight children in their intervention in order to separate primary prevention from treatment. It should be noted that there were a number of quality studies excluded by taking this step, and this is a limitation in applicability. This review also highlights the paucity of studies conducted in primarily minority or poor populations, where the biggest obesity burden lies.[1,33] Given the cultural contexts in which coaching, behavioral change, and motivational interviewing take place, testing whether these methods work in diverse populations is needed.

It has becoming increasingly recognized that weight status in early childhood is a significant predictor for weight status and its associated comorbidities later in life. From the studies included in this systematic review, more intensive, multidisciplinary treatment interventions provide the strongest evidence of effectiveness. For individual providers, the evidence synthesized in this review can be used to target individual therapy where indicated, understanding that the data suggest a relatively intense intervention is likely needed. For policy makers, scalability and sustainability will need to be considered as these approaches are applied to addressing the public health scope of early childhood obesity.

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REFERENCES

1. Ogden CL, Carroll MD, Kit BK, et al. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA*. 2014;311:806–814.
2. Cunningham SA, Kramer MR, Narayan KMV. Incidence of childhood obesity in the United States. *N Engl J Med*. 2014;370:403–411.
3. Singh AS, Mulder C, Twisk JWR, et al. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obes Rev*. 2008;9:474–488.
4. Waters E, Bj H, Brown T, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2011;CD001871.
5. Showell NN, Fawole O, Segal J, et al. A systematic review of home-based childhood obesity prevention studies. *Pediatrics*. 2013;132:e193–e200.
6. Bleich SN, Segal J, Wu Y, et al. Systematic review of community-based childhood obesity prevention studies. *Pediatrics*. 2013;132:e201–e210.
7. Monasta L, Batty GD, Macaluso A, et al. Interventions for the prevention of overweight and obesity in preschool children: a systematic review of randomized controlled trials. *Obes Rev*. 2011;12:e107–e118.
8. Hesketh KD, Campbell KJ. Interventions to prevent obesity in 0–5 year olds: an updated systematic review of the literature. *Obesity*. 2010;18(suppl 1):S27–S35.
9. Bond M, Wyatt K, Lloyd J, et al. Systematic review of the effectiveness of weight management schemes for the under fives. *Obes Rev*. 2011;12:242–253.
10. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: methods and development. *Vital Health Stat 11*. 2002;1–190.
11. WHO child growth standards based on length/height, weight and age. *Acta Paediatr Suppl*. 2006;450:76–85.
12. Cole TJ. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320:1240–1243.
13. Higgins J, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions*. Cochrane Collaboration; 2011. Version 5.1.0. Available at: www.cochrane-handbook.org. Accessed July 25, 2014.
14. Bocca G, Corpeleijn E, Stolk RP, et al. Results of a multidisciplinary treatment program in 3-year-old to 5-year-old overweight or obese children: a randomized controlled clinical trial. *Arch Pediatr Adolesc Med*. 2012;166:1109–1115.
15. Kelishadi R, Zemel MB, Hashemipour M, et al. Can a dairy-rich diet be effective in long-term weight control of young children? *J Am Coll Nutr*. 2009;28:601–610.
16. Quattrin T, Roemmich JN, Paluch R, et al. Efficacy of family-based weight control program for preschool children in primary care. *Pediatrics*. 2012;130:660–666.
17. Stark LJ, Spear S, Boles R, et al. A pilot randomized controlled trial of a clinic and home-based behavioral intervention to decrease obesity in preschoolers. *Obesity*. 2011;19:134–141.
18. Taveras EM, Gortmaker SL, Hohman KH, et al. Randomized controlled trial to improve primary care to prevent and manage childhood obesity: the High Five for Kids study. *Arch Pediatr Adolesc Med*. 2011;165:714–722.
19. Van Grieken A, Veldhuis L, Renders CM, et al. Population-based childhood overweight prevention: outcomes of the "Be Active, Eat Right" study. *PLoS One*. 2013;8:e65376.
20. Kuhl ES, Clifford LM, Bandstra NF, et al. Examination of the association between lifestyle behavior changes and weight outcomes in preschoolers receiving treatment for obesity. *Health Psychol*. 2014;33:95–98.
21. Schwartz RP, Hamre R, Dietz WH, et al. Office-based motivational interviewing to prevent childhood obesity: a feasibility study. *Arch Pediatr Adolesc Med*. 2007;161:495–501.
22. Woo Baidal JA, Price SN, Gonzalez-Suarez E, et al. Parental perceptions of a motivational interviewing-based pediatric obesity prevention intervention. *Clin Pediatr*. 2013;52:540–548.

23. Resnicow K, Davis R, Rollnick S. Motivational interviewing for pediatric obesity: conceptual issues and evidence review. *J Am Diet Assoc*. 2006;106:2024–2033.
24. Quattrin T, Roemmich JN, Paluch R, et al. Treatment outcomes of overweight children and parents in the medical home. *Pediatrics*. 2014;134:290–297.
25. Oude Luttikhuis H, Baur L, Jansen H, et al. Interventions for treating obesity in children. *Cochrane Database Syst Rev*. 2009;CD001872.
26. McGovern L, Johnson JN, Paulo R, et al. Clinical review: treatment of pediatric obesity: a systematic review and meta-analysis of randomized trials. *J Clin Endocrinol Metab*. 2008;93:4600–4605.
27. Savoye M, Shaw M, Dziura J, et al. Effects of a weight management program on body composition and metabolic parameters in overweight children: a randomized controlled trial. *JAMA*. 2007;297:2697–2704.
28. Hughes AR, Stewart L, Chapple J, et al. Randomized, controlled trial of a best-practice individualized behavioral program for treatment of childhood overweight: Scottish Childhood Overweight Treatment Trial (SCOTT). *Pediatrics*. 2008;121:e539–e546.
29. Armstrong MJ, Mottershead TA, Ronksley PE, et al. Motivational interviewing to improve weight loss in overweight and/or obese patients: a systematic review and meta-analysis of randomized controlled trials. *Obes Rev*. 2011;12:709–723.
30. Davoli AM, Broccoli S, Bonvicini L, et al. Pediatrician-led motivational interviewing to treat overweight children: an RCT. *Pediatrics*. 2013;132:e1236–e1246.
31. Wong EMY, Cheng MMH. Effects of motivational interviewing to promote weight loss in obese children. *J Clin Nurs*. 2013;22:2519–2530.
32. Walpole B, Dettmer E, Morrongiello BA, et al. Motivational interviewing to enhance self-efficacy and promote weight loss in overweight and obese adolescents: a randomized controlled trial. *J Pediatr Psychol*. 2013;38:944–953.
33. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(suppl):S164–S192.