Interventions to Prevent Obesity in 0–5 Year Olds: An Updated Systematic Review of the Literature

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The small number and recency of the early childhood obesity-prevention literature identified in a previous review of interventions to prevent obesity, promote healthy eating, physical activity, and/or reduce sedentary behaviors in 0–5 year olds suggests this is a new and developing research area. The current review was conducted to provide an update of the rapidly emerging evidence in this area and to assess the quality of studies reported. Ten electronic databases were searched to identify literature published from January 1995 to August 2008. Inclusion criteria: interventions reporting child anthropometric, diet, physical activity, or sedentary behavior outcomes and focusing on children aged 0–5 years of age. Exclusion criteria: focusing on breastfeeding, eating disorders, obesity treatment, malnutrition, or school-based interventions. Two reviewers independently extracted data and assessed study quality. Twenty-three studies met all criteria. Most were conducted in preschool/childcare (n = 9) or home settings (n = 8). Approximately half targeted socioeconomically disadvantaged children (n = 12) and three quarters were published from 2003 onward (n = 17). The interventions varied widely although most were multifaceted in their approach. While study design and quality varied most studies reported their interventions were feasible and acceptable, although impact on behaviors that contribute to obesity were not achieved by all. Early childhood obesity-prevention interventions represent a rapidly growing research area. Current evidence suggests that behaviors that contribute to obesity can be positively impacted in a range of settings and provides important insights into the most effective strategies for promoting healthy weight from early childhood.

INTRODUCTION

The prevalence of obesity is high and increasing in all age groups and most countries worldwide (1,2), with these trends being observed from early in life (3). Behaviors that contribute to obesity, including high-energy dense food consumption (4) and frequent sedentary behavior (5–7), are also prevalent during early childhood (0–5 years of age). Evidence regarding physical activity levels in young children remains inconclusive (8) which is likely due to issues of measurement. Declining diet quality (9), increasing sedentary behavior (10), and decreasing physical activity levels across childhood (11) suggest these obesity-promoting behaviors observed early in life persist.

Given these trends, early intervention to positively impact weight and behaviors that contribute to obesity is vitally important. In 2006, these authors (12) conducted a systematic review of the literature to assess the effectiveness of interventions designed to prevent obesity, promote healthy eating, promote physical activity, and/or reduce sedentary behaviors in 0–5 year olds. The aim was to capture a broad range of research with potential to have positive impact, regardless of study design. Nine studies were identified, predominantly published since 2003. The small number and recency of the early childhood obesity-prevention literature suggests this is a new and developing research area. A number of reviews of obesity prevention during early childhood have been published in recent years (13–17), all with differing inclusion criteria and predominantly focusing on the preschool age group. The current review was conducted to provide an update of the emerging evidence in this area and to assess the quality of studies reported. The inclusion in this review of a broad range of study designs enables a comprehensive overview of the obesity-prevention literature. The incorporation of a published (18) study quality assessment tool aims to assist with comparison of disparate study designs.

METHODS AND PROCEDURES

The search strategy employed for this review involved the following stages: (i) identification of reviews of childhood obesity prevention and interventions that targeted behaviors that contribute to obesity. Reviews were hand searched to identify relevant publications and identify key researchers and research programs from which additional publications were identified; (ii) key informants were contacted to identify any new or emerging literature; (iii) systematic searches of 10 electronic databases were conducted: Academic Search Premier, Cumulative Index to Nursing and Allied Health Literature, Cochrane Central Register of Controlled Trials, Communication, Global Health, Health Source: Nursing/Academic, Medline, Psycharticles, PsychINFO, Psychology, and Behavioral Sciences

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Collection. The search strategy involved the keywords: (intervention studies OR communications media OR early intervention OR primary prevention OR health education) combined with each of (overweight), (child nutrition OR diet OR feeding behavior OR feeding behaviour), (physical activity OR play OR exercise), and (television OR sedentary OR inactivity). Inclusion criteria were: peer-reviewed; English-language; published January 1995–August 2008 (regardless of when intervention itself was conducted); reporting an intervention aiming to positively impact weight and/or behaviors that contribute to obesity; reporting child anthropometric, diet, physical activity, or sedentary behavior outcomes; intervention targeting children aged 0–5 years of age. Exclusion criteria were: focusing on breastfeeding, eating disorders, obesity treatment, malnutrition, or elementary school-based interventions.

All abstracts identified from the literature searches were screened by one author for potential inclusion suitability; 96 abstracts were judged to be potentially relevant and copies of full articles were retrieved. Assessment by both authors deemed 23 of these papers met all inclusion criteria and were therefore included in this review with data extracted independently by both authors.

A six-component rating scale (18) was used to assess study quality. This tool assesses selection bias, study design, confounders, blinding, data collection methods, and withdrawals and dropouts. A rating of weak, moderate, or strong is given for each component assessed based on specific criteria. Where a component is not described a rating of weak is given, except for blinding where a moderate rating is given if blinding is not described. A global study rating is derived of weak (two or more weak ratings from the six components), moderate (less than four strong ratings and one weak rating), or strong (four strong ratings with no weak ratings). Both authors independently assessed study quality; any discrepancies in component ratings were discussed and resolved.

RESULTS

The 23 included studies were delivered through a variety of settings: preschool/childcare, home, group, primary care, and mixed settings. Approximately two-thirds involved multifaceted interventions (n = 14) and a similar proportion were conducted in the United States (n = 15). Just over half of the studies targeted socioeconomically disadvantaged families (n = 12) and three quarters were published from 2003 onward (n = 17). Design, methodological rigor and effectiveness varied substantially (see **Table 1**).

Description of key studies

Nine of the 23 studies were described in our previous review paper (12). Summaries of the remaining 14 studies appear below, grouped by setting. Details of all 23 studies, including a rating of methodological rigor (18), are provided in **Table 1**. Only three studies received a strong methodological rating, all conducted within the preschool/childcare setting. Of the remaining 20 studies, 14 were rated as moderate and 6 were rated as methodologically weak.

Preschool/childcare-based studies. The preschool/childcare setting was the most commonly targeted setting for interventions involving young children. Despite diverse study designs, populations and targeted outcomes, one-third of these studies achieved clear success in modifying their respective outcomes of interest (reduced fat intake (19), increased physical activity (20), and reduced sedentary behavior (5), respectively). A further third (21–23) showed some evidence of success on some outcomes. Unlike studies reported in other settings, the methodological quality of these studies was generally high (strong or moderate rating). However, inconsistencies within the preschool and childcare setting (e.g., structured vs. unstructured, sessional vs. long-day), makes generalizability difficult. Two studies (5,21) conducted in the preschool/childcare setting were described in our previous review (12), a further seven are described below.

Alhassan and colleagues' (24) pilot randomized controlled trial (RCT) aimed to increase daily physical activity in 3–5-year-old low-income Latino children by increasing outdoor free-play time in their structured preschool setting. Intervention group children (n = 18) received double the usual amount of outdoor free-play time (4 × 30-min sessions) for two consecutive days. Children in the control group (n = 15) received their usual 2 × 30-min sessions. Children in both groups (59% response) wore accelerometers for 4 days, 2 days before the intervention and the two intervention days. Baseline physical activity levels between groups were similar with all children spending >90% of their time being sedentary. No between group differences were found for changes in average activity counts, percent of time spent in sedentary, light, or moderate-to-vigorous physical activity for the total day, during school hours or during the after school/evening period.

A cluster-RCT (Hip-Hop to Health Jr.) aiming to prevent obesity in minority 3–5 year olds delivered an identical intervention to two separate cohorts. Results for the first cohort, of predominantly African-American children (21) indicated lower BMI increases in the intervention group at both 1- and 2-year follow-ups and were reported in our previous review (12). Results for the second cohort, of predominantly Latino children, are described here (25). Twelve Head Start preschools servicing predominantly Latino children were randomly allocated to a weight control intervention or general health programme (control group). The weight control intervention (n = 202) involved three 40-min sessions/week for 14 weeks comprising 20-min healthy eating or physical activity education and 20-min aerobic physical activity. Parents received weekly homework and newsletters containing complementary dietary and physical activity information, and were offered twice weekly aerobics classes. The control group (n = 199) received a general health programme involving 20-min general health education once per week for 14 weeks and parents received a weekly general health newsletter. While response rate was not reported, postintervention (14 weeks) retention was 97%, with 86% and 85% completing 1- and 2-year follow-up assessments, respectively. At baseline, control group children had higher mean BMI z-scores (P = 0.02) and a greater proportion were Latino (89 vs. 73%, P < 0.001). No differences in BMI, dietary, physical activity, or television viewing outcomes were observed between groups at postintervention, 1- or 2-year follow-ups.

Mo-Suwan and colleagues (22) aimed to reduce obesity prevalence in preschool children by implementing an exercise program. This cluster-RCT involved second year kindergarten classes from two preschools. Classes were randomly allocated to the control or intervention condition. Control group children (n = 145) received their regular physical activity program. Children in the intervention group (n = 147; 75%

Table 1 Summary of studies: focus, design, sample, quality assessment, and outcome

Study	Focus				Design	*N*	Age at commencement	Duration	Follow-ups	Quality[a]	Outcome[b]
	Anthro	Diet	PA	SB							
Preschool/childcare settings											
Alhassan *et al*. (24)			X		Pilot-RCT	32	3–5 Years	2 Days	0	2	0
Dennison *et al*.[c] (5)				X	Cluster-RCT	176	2.5–5.5 Years	6 Months	6 Months	2	+
Fitzgibbon *et al*.[c] (21)	X	X	X		Cluster-RCT	409	3–5 Years	14 Weeks	1 and 2 Years	2	?
Fitzgibbon *et al*. (25)	X	X	X		Cluster-RCT	401	3–5 Years	14 Weeks	1 and 2 Years	2	0
Mo-Suwan *et al*. (22)	X		X		Cluster-RCT	292	Mean 4.5 years	30 Weeks	0	1	?
Reilly *et al*. (26)	X		X	X	Cluster-RCT	545	Mean 4.5 years	24 Weeks	6 Months	2	0
Specker and Binkley (28)	X		X		RCT	239	3–5 Years	12 Months	6 and 12 Months	2	?
Trost *et al*. (20)			X		RCT	42	3–5 Years	8 Weeks	0	1	+
Williams *et al*. (19,30)		X			CCT	≈1,000	2–5 Years	2 Years	0	1	+
Home-based settings											
Cottrell *et al*. (34)		X	X		Cluster-RCT	50	4–6 Years	4 Weeks	0	3	?
Fitzpatrick *et al*. (37)		X			CCT	39	Birth	1 Year	0	2	+
Harvey-Berino and Rourke[c] (31)		X	X		RCT	43	9 Months–3 years	16 Weeks	0	2	+
Johnson *et al*. (35)		X			RCT	232	Birth	1 Year	7 Years	2	?
Sääkslahti *et al*. (38)			X		RCT	228	4–6 Years	3 Years	0	3	+
Wardle *et al*.[c] (32)		X			RCT	143	34–38 Months	14 Days	0	2	+
Watt *et al*. (39)		X			RCT	312	3 Months	9 Months	6 Months	2	0
Worobey *et al*.[c] (33)		X			Pre/post	60	Mean 27 months	8 Months	0	3	+
Group-settings											
Condrasky *et al*. (41)		X			CCT	29	Preschool	6 × 2 h	0	3	0
McGarvey *et al*.[c] (40)		X	X		CCT	336	3 Years	1 Year	1 Year	2	?
Primary care settings											
Johnson *et al*.[c] (42)			X	X	Interrupted time series	10,204	n/a	6 Months	6 Months	3	?
Talvia *et al*. (45)		X			RCT	1,062	7 Months	10 Years	0	3	?
Mixed setting											
Horodynski and Stommel[c] (46)		X		X	CCT	135	19 Months	6 Months	0	2	?
Johnston *et al*. (47)		X		X	CCT	439	Birth (prebirth)	30 Months	0	2	+

Anthro, anthropometry; CCT, controlled clinical trial (nonrandomized); PA, physical activity; RCT, randomized controlled trial; SB, sedentary behavior.
[a]Quality (methodological rigor as assessed by six-component rating scale described in Methods and Procedures section (18)): 1, strong; 2, moderate; 3, weak.
[b]Outcome: +, intervention was beneficial; 0, no effect; ?, unclear; beneficial for some but not all outcomes or participants. [c]Reported in previous review (12).

response) received an additional 15-min walking and 20-min aerobic dance three times per week for ~30 weeks. Outcomes were assessed at baseline, twice during the intervention, and at the conclusion of the intervention. The prevalence of obesity assessed from two measures of triceps skin-fold thickness decreased in the intervention group (12.2–8.8% ($P = 0.06$) more than in the control group (11.7–9.7%, $P = 0.18$)). No between group differences were found in BMI or weight/height[3]. However, the likelihood of having an increased BMI slope was lower in intervention than control group girls (odds ratio = 0.32, 95% confidence interval = 0.18, 0.56), but not boys.

Reilly and colleagues (26) aimed to reduce BMI with the Movement and Activity Glasgow Intervention in Children, by increasing physical activity and reducing sedentary behavior in this cluster-RCT. A random sample of 36 preschools were selected from 104 of a possible 124, stratified by type of preschool (school, class, extended day, private sector), size (area and number of children), and area socioeconomic status. Pairs of preschools from the same stratum were randomly selected and randomly allocated to intervention or control group. Two staff from each intervention preschool attended three training sessions on the enhanced physical activity program consisting of three 30-min physical activity sessions per week for 24 weeks. In addition, intervention group families were given information on linking physical play at preschool and home and opportunities for increasing physical activity and reducing television viewing time. Posters on increasing physical activity through walking and play were displayed in preschool centers for 6 weeks. Baseline data was provided from 545 children (47% response). No between group differences in BMI were observed at 6 months (before end of intervention) or 12 months (5–6-months postintervention). Similarly no differences were observed for physical activity assessed by accelerometry on a subsample of 285 children at 6-month follow-up (not assessed at 12 months). Children in the intervention group showed significant improvement in fundamental movement skills at 6 months (not assessed at 12 months).

Multiple papers (23,27,28) report data from a RCT aiming to improve bone mineral content in 3–5 year olds. The intervention involved four arms: (1) calcium supplement plus physical activity ($n = 43$), (2) calcium supplement plus fine motor activity control ($n = 45$), (3) placebo plus physical activity ($n = 45$), and (4) placebo plus fine motor activity control ($n = 45$). Results were reported for the physical activity program independently; arms 1 and 3 results were compared with arms 2 and 4. The physical activity intervention consisted of 30-min of gross motor activity 5 days/week for 12 months involving a 5-min warm up, 20-min jumping, hopping, and skipping activities, and 5-min cool down. Five days per week for 12 months, children in the control group received 30-min of fine motor activity (e.g., art and craft) designed to keep them sitting quietly. Of the 239 children providing baseline data (response rate not reported), 74% provided mid-intervention (6-months) and postintervention (12-months) outcomes; 90% of these completed 6-months and 1-year postintervention follow-ups ($n = 161$). Children in the intervention group recorded significantly higher physical activity levels, assessed by accelerometry, than control children mid- and postintervention which persisted 6-months postintervention but was not observed 12-months postintervention (6- and 12-month postintervention data collected on subsample of 60 children). No differences in body weight or percent body fat, assessed by dual-energy X-ray absorptiometry, were observed at any time point.

Numerous papers (19,29,30) report the Healthy Start Project, a 3-year demonstration project implemented in Head Start preschools for socioeconomically disadvantaged children, with the aim of reducing cardiovascular risk factors in 3–5 year olds. Healthy Start involved a usual care control condition and two intervention conditions and was implemented for 2 years. One intervention condition involved menu modification designed to reduce the total fat and saturated fat content of meals and snacks served at preschool. The second intervention condition involved the menu modification plus a curriculum component whereby children's health education focused primarily on nutrition. Allocation to one of the two intervention conditions was random, however, control group preschools were those who indicated they were unable to make changes to their food service. Sample size is unclear, with reports of the number of children involved differing between papers, from 296 to >1,000. There was a significant decrease in saturated fat from 13.5 to 8.0%, and total fat content from 31 to 25% of daily energy of meals served at intervention preschools, with no change observed in control preschools ($P < 0.001$). Dietary observation found reduction in percent energy from total fat and saturated fat consumed by children in the intervention preschools. Children in both intervention groups demonstrated a significant decrease in total serum cholesterol compared to control group children (−6.0 vs. −0.4 mg/dl) but there was no impact on height to weight ratio.

Trost and colleagues (20) report a RCT aiming to increase preschool children's physical activity at a single childcare center with four classes of children attending an inclusive half-day preschool program for 2½ h on each of 4 days/week. After 2 weeks of baseline assessment, classes were randomized to intervention (20 children) or a usual care control condition (22 children; 88% response). Intervention classes received an 8 week "Move and Learn" program involving integration of physical activity into all aspects of the curriculum. Teachers and staff in the intervention classroom attended a 3-h training session and received a video demonstrating "Move and Learn" activities. During each preschool session teachers selected a minimum of two activities lasting ≥10 min to conduct. Physical activity was monitored by accelerometers and 15 min of direct observation during preschool sessions 2 days a week. Physical activity levels, assessed by accelerometer, were similar between groups for the first 6 weeks of the program. Intervention group children demonstrated significantly higher levels of moderate-to-vigorous intensity physical activity than controls in the final 2 weeks and the final 4 weeks when only classroom time was assessed. Higher levels of moderate-to-vigorous intensity

physical activity were found in intervention group children compared with control group children for the duration of the program using direct observation.

Home-based studies. The home was another common setting for interventions involving young children. While each of the home-based interventions identified involved quite different population groups, interventions, and outcomes of interest, most showed some positive impact on some behaviors that contribute to obesity. Three (31–33) home-based studies were described in our previous review paper (12), a further five are described below.

Cottrell and colleagues (34) aimed to assess the impact of a 4-week physical activity plus dietary information intervention called CARDIAC-Kinder. In a cluster-RCT children were recruited via preschools for this intervention which was delivered in the home setting. The intervention group received a pedometer for themselves and a parent plus a log book to record their daily steps. Parents received information about age-appropriate diet and exercise guidelines for preschool children and ideas on how to increase exercise, particularly steps. Intervention children whose BMI was ≥85th percentile (number not reported) were also given information on ways to reduce caloric intake. Children in the control group received a pedometer for themselves (but not their parent) plus a daily steps log book. Control parents received the same information about age-appropriate diet and exercise guidelines but no information on how to increase exercise. While 437 children (50% response) from rural areas were recruited to receive the intervention, data were available for only 24 intervention and 26 control group children. Higher mean weekly step counts were recorded by intervention children compared with controls, however, differences were only significant in the final week of the intervention (9,815 vs. 7,799 steps). Intervention group children consumed significantly fewer sweets per week than those in the control group but differences were not reported for average weekly intake of fruits, vegetables, meat, or bread.

Seven-year follow-up data are reported (35) for a RCT involving an intervention focusing on parenting skills for first-time parents in disadvantaged areas. The Community Mothers' Programme (36) was delivered by volunteer "community mothers" identified by local public health nurses. Each volunteer supported 5–15 first-time parents via once monthly visits over their child's first year of life, focused on health care, nutritional improvement, and child development. Results immediately postintervention fall outside the scope of this review (published pre-1995) but showed that children in the intervention group (n = 127) were significantly more likely to consume appropriately from all food groups than were controls (n = 105). In this study, diet was assessed by 24-h recall with intakes categorized as inappropriate when the subject reported eating not enough or too much from a food group when compared to dietary guidelines. The 7-year postintervention follow-up assessed one-third of the original group (38 intervention and 38 control mothers) when children were 8-years old. No significant differences in overall child diets were observed between groups. However, children in the intervention group performed consistently better, from 11% to 63% better, than control group children for individual food groups. While not significant, intervention group mothers were 12% more likely to limit children's television viewing to 9 PM (P = 0.09).

Fitzpatrick and colleagues (37) aimed to assess the Community Mothers' Programme (described above) (36), in a socially marginalized and disadvantaged traveling community. Outcomes for these mothers and children were compared to those of intervention and control families in the original RCT informing this work (36) as recruitment of a concurrent control group was considered unachievable. In comparison to mothers involved in the RCT, these disadvantaged mothers (n = 39; response rate not reported) were significantly older and less educated than RCT control but not RCT intervention mothers. Their children were significantly older than children of mothers involved in the RCT, and were not always first-born. Mothers in this study received significantly fewer home visits than did mothers involved in the RCT (mean 8.9 vs. 9.5 visits, respectively). Children in this study scored better than RCT controls for consumption of all food groups, except fruit, and for energy intake. They were also less likely to begin cow's milk before 26 weeks of age.

Sääkslahti and colleagues (38) aimed to influence 4–6-year-old children's physical activity through a 3-year family-based intervention. Families involved in a larger study were randomly selected to participate in this RCT (response rate not reported). The control group (n = 112) received no information, while intervention group parents (n = 116) attended three annual intensive educational meetings with researchers. Meetings dealt with the importance of sensory integration (thought to occur through children's involvement in physical activity), relations between physical activity, cognitive development and academic achievement, and how and where to find physical activities and venues that children might enjoy. Parents were also provided with printed education materials twice yearly and relevant review articles. In the second year of the intervention, parents were asked to listen to a radio program entitled "The importance of being physically active". Intervention group children attended three annual physical activity demonstration sessions lasting 45–60 min. Attrition was 26% of intervention and 24% of control families. Children's physically activity was assessed using diaries completed by the parents twice yearly over the 3 years. The intervention group spent less time playing indoors (P = 0.05) and more time playing outdoors (P = 0.04) than the control group. Time spent outdoors increased in both groups over the 3 years, but more strongly in the intervention group. Further, intervention but not control group children spent more time in "high-activity play" (e.g., running, jumping, and other physical exercise) as they grew older (P < 0.001).

The Infant Feeding Peer Support Trial (39), a RCT, aimed to improve infant feeding practices to a consecutive birth cohort by providing peer support to low-income mothers. Control group mothers received usual care (n = 155) and intervention group mothers (n = 157; 82% response) received monthly

home visits from matched peer support volunteers, commencing when their baby was 3 months old until their baby was 12 months of age. Volunteers provided nonjudgmental advice and support and practical assistance on infant feeding practices, particularly weaning. Outcomes were assessed at baseline, postintervention (77% retention), and 6-month follow-up (68% retention). At postintervention and follow-up, no differences between groups were observed in child anthropometric measurements or nutrient intake. Children in the intervention group were more likely to be eating the same foods as the rest of the family and to be eating three meals per day than the control group postintervention, when 12 months of age.

Group-based studies. Two group-based studies were identified, one (40) described in our previous review (12) and one described below. These studies were quite different in setting and focus, but both demonstrated some level of effectiveness. While not utilizing existing social groups per se, both tapped into groups in existing settings thus participants within groups are likely to have been similar to one another and potentially familiar with one another. These studies demonstrate the potential positive benefits of group-based programs.

Condrasky and colleagues' (41) sought to promote healthful eating behaviors by teaching parents and caregivers basic nutrition, food selection, menu planning, and food preparation skills in a nonrandomized controlled trial. The program, Cooking with a Chef, teamed a chef with a nutrition educator. Lessons were conducted in 2-h sessions during the week in late morning blocks and concluded with serving lunch. Although not explicitly reported, it appears there were six sessions covering menu planning, using fruits and vegetables, culinary skills, use of flavors, food labels, and dietary fiber. The intervention group ($n = 15$) comprised a random sample of parents and caregivers of preschool children from a church group. The control group ($n = 14$; response rate not reported) were randomly selected from a different church group. Pre-post intervention comparisons showed the number of daily fruit servings consumed by children in the intervention group increased after the intervention, although this did not reach statistical significance ($P < 0.10$).

Primary care-based studies. Two studies (42) delivered in the primary care setting were described in our previous review (12). Additional results for one of these studies (43,44) have recently been published and are described below. Both studies showed some evidence of positive impact on the outcomes of interest. Despite both being rated as methodologically weak, these results suggest primary care may be a useful setting to initiate interventions during the early childhood period.

Recently published (45) fruit and vegetable intake outcomes from a RCT that recruited families via well-baby clinics and was reported in our previous review (12) are described here. Intervention families ($n = 540$) received individualized and repeated parental dietary counseling focused on the reduction of the child's saturated fat intake with the ultimate aim of reducing coronary heart disease risk factors. Counseling sessions occurred at 1–3 month intervals from when the child was aged 7 months until 2 years of age and then biannually to 10 years. Once children were aged 7 years, separate dietary counseling sessions were organized for the child and the parents. Control group parents ($n = 522$) were seen biannually until the child was aged 7 years and annually thereafter with limited discussion of diet and no counseling on fat intake. The proportion of energy provided by fruits and vegetables reduced over the 10 years of assessment, although total grams of vegetables increased throughout childhood. Intervention boys, but not girls, consumed significantly more vegetables than controls (mean difference 3.2 g/day; confidence interval 1.5–4.9; $P < 0.001$). Intervention boys also consumed significantly more fruit than controls (mean difference 10.1 g/day; confidence interval 5.3–14.9; $P < 0.001$).

Mixed-setting studies. Studies in which the intervention was delivered across more than one setting were classified as mixed-setting studies. Two such studies were identified, one (46) described in our previous review (12) and one described below. Both studies involved nonrandomized controlled trials, were rated as moderate methodological quality and focused on improving diet and reducing television viewing and showed some evidence of success.

Johnston and colleagues (47) compared usual care (control) from birth with a clinic program known as Healthy Steps for Young Children, implemented with and without an additional antenatal program known as PrePare. The Healthy Steps program consists of risk reduction activities and universal components, including developmental screening, anticipatory guidance, and follow-up services delivered by a Healthy Steps specialist. Services were delivered via home visits, parent-initiated telephone support and parenting classes. The PrePare program was designed to enable the Healthy Steps specialist to also work with the parent during pregnancy. PrePare was delivered as three home visits at 20, 27, and 34 weeks gestation focused on helping parents create a safe, knowing, and welcoming environment for their baby and providing screening and intervention for targeted risk factors such as smoking, depression, and domestic violence. A consecutive sample of 439 pregnant women (80% response rate) were recruited from five primary care clinics. Outcomes were assessed when the child was 30 months old (78% retention). Of importance to this review, parents who received Healthy Steps, when compared to the control group, were significantly less likely to allow their child to watch >1 h of television (34 vs. 50%). There were no dietary or physical activity benefits of combining PrePare with Healthy Steps.

DISCUSSION

This article appraised the peer-reviewed literature published between 1995 and mid-2008 that reported interventions which aimed to support parents and other caregivers to positively influence young children's body weight and/or the obesity-promoting behaviors of dietary intake, physical activity, and sedentary

behaviors. This review aimed to update and extend a previous review conducted by these authors in 2006 (12). It is clear that obesity-prevention interventions focusing on children between the ages of birth and 5 years are gaining increasing attention from researchers, as evidenced by the rapid increase in publications in recent years. Further, it is likely that additional programs targeting young children have or are currently being conducted but have not yet been published in the peer-reviewed literature. In fact, the authors are aware of several studies currently being conducted with this age group (48,49). However, the evidence base remains relatively sparse, particularly when compared to interventions that focus on school-aged children. Given that obesity (3) and behaviors that contribute to obesity (4–6) have been shown to be prevalent during early childhood and to track across childhood (9–11), the importance of early intervention cannot be understated.

While the 23 studies identified in this review varied widely in their objectives, designs, mode, and setting of intervention delivery, there were some common elements to their design. Most studies employed multiple modes of intervention delivery and the majority of studies were conducted in either the home or preschool/childcare settings. While the majority of studies included in this review employed a design to provide the highest level of evidence, the RCT (50), the quality, and reporting of some studies was less than ideal. It should be noted, however, that the quality rating (18) employed in this review precluded well-designed studies from receiving the highest quality rating (strong) if either their response or retention rates fell below 60%, aspects of the study which often fall outside the researchers control. In general, studies conducted in the preschool/childcare setting received the highest quality ratings (all rated as strong or moderate, no studies rated as weak). The structured nature of these settings may make it easier for researchers to apply rigorous methodologies than in the less predictable home-based settings.

While some studies appeared effective, being able to show some level of effectiveness on some behaviors that contribute to obesity in young children, others showed no impact on the outcomes relevant to this review. In particular, many of the studies reported in the preschool/childcare setting showed no evidence of effect on behaviors that contribute to obesity despite, in many cases, strong study designs. Many of the studies implemented in the preschool/childcare environment had a focus on increasing physical activity, and given the very low levels of physical activity typically observed in preschool settings (7) there appears to be great scope for improving physical activity in these settings, despite the limited success reported by the studies reviewed here. While a number of factors may help to explain the lack of findings in these studies, including insufficient sample sizes to detect what may be small but meaningful changes, a notable observation is that most of these preschool/childcare-based studies lacked a parental component. It is possible that during these early childhood years, parental involvement is important and perhaps vital for observable and lasting changes to be effected in childhood behavior. Further, the preschool settings in which many of these studies were conducted were school-like (e.g., structured curriculum and timetabling, long-day rather than sessional programs). Traditionally, the literature in the area of obesity-prevention interventions has focused upon interventions targeting school-aged children which have been predominantly school-based and demonstrated limited success (51). It is possible that the preschool setting interventions described here are reflective of these school-based studies reported in older children and suffer the same limited success.

Despite the diversity of the study methodologies and intervention designs employed in the studies reviewed, certain common aspects may be useful in the consideration of the most promising strategies by which to support parents and other caregivers to achieve healthy weight outcomes in young children. Interventions which showed evidence of success were designed to impact not only on knowledge but also on skills and competencies suggesting a social behavioral theory underpinning. As discussed above, lack of parental involvement may have limited success suggesting a vital role for parents in facilitating real and sustainable behavior changes during this early childhood period.

Differences in demographic characteristics of participants and settings of studies reported in this review are likely to limit the generalizability of the studies reported. In particular, two-thirds of identified studies were conducted in the United States and may not be generalizable to settings in other countries. Approximately half of the studies targeted socioeconomically disadvantaged families, predominantly through existing infrastructures which, again, may not exist in other countries and which may not be transferable to the wider population. However, there are likely to be points of overlap in population groups and infrastructures which may facilitate transference of interventions to different settings.

A common limitation of the studies reviewed was failure to report data on the cost-effectiveness of the intervention programs evaluated. Given the intensive nature of many of the interventions reported and the small impacts resulting from some interventions, estimates of cost-effectiveness would be beneficial. Similarly, studies did not report the theoretical underpinning of their interventions. Such information could assist in assessing whether particular theoretical frameworks are more likely to lead to the development of successful obesity-prevention interventions. A further observation is that, despite many studies employing a randomized controlled design, most failed to report their studies using the Consolidated Standards of Reporting Trials (CONSORT) guidelines (52). As such it was often difficult to elicit the required information to assess the quality and rigor of the study design and methodologies used.

Another noteworthy observation is that this review found little evidence of continuity in research activities to build and advance the evidence base in this area. There was no evidence of multiple separate studies conducted by the same researchers which attempt to build on lessons learnt from previous

intervention attempts. With the exception of the Community Mothers Programme (35,37), and Hip-Hop to Health Jr. (21,25) there was little evidence of attempts to test generalizability of program success to different population groups. The current approach appears to be piecemeal, and likely reflects the current way research is funded.

The studies reviewed here provide a mixed picture of the ability of intervention programs to change behaviors that contribute to obesity in young children. However, importantly they support the premise that parents and caregivers, even those most at risk of rearing children who will become overweight or obese, are receptive to intervention programs and in some cases can be supported to make positive changes to dietary, physical activity, and sedentary behaviors of their young children. Further workers engaged with socioeconomically disadvantaged groups who are at higher risk for obesity, and those providing childcare and early education services are willing to implement obesity-prevention programs. While the evidence base is growing, there remains an urgent need to build in a substantial and integrated way upon this existing evidence base.

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DISCLOSURE

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