



Parent-focused change to prevent obesity in preschoolers: Results from the KAN-DO study

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ABSTRACT

Objective. The study presents the immediate post-intervention results of Kids and Adults Now – Defeat Obesity!, a randomized controlled trial to enhance healthy lifestyle behaviors in mother–preschooler (2–5 years old) dyads in North Carolina (2007–2011). The outcomes include change from baseline in the child's diet, physical activity and weight, and in the mother's parenting behaviors, diet, physical activity, and weight.

Method. The intervention targeted parenting through maternal emotion regulation, home environment, feeding practices, and modeling of healthy behaviors. 400 mother–child dyads were randomized.

Results. Mothers in the intervention arm, compared to the control arm, reduced instrumental feeding (−0.24 vs. 0.01, $p < 0.001$) and TV snacks (−0.069 vs. −0.24, $p = 0.001$). There were also improvements in emotional feeding ($p = 0.03$), mother's sugary beverage ($p = 0.03$) and fruit/vegetable ($p = 0.04$) intake, and dinners eaten in front of TV ($p = 0.01$); these differences were not significant after adjustment for multiple comparisons.

Conclusion. KAN-DO, designed to maximize the capacity of mothers as agents of change, improved several channels of maternal influence. There were no group differences in the primary outcomes, but differences were observed in the parenting and maternal outcomes and there were trends toward improvement in the preschoolers' diets. Long-term follow-up will address whether these short-term trends ultimately improve weight status.

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Background

Having an overweight parent triples the likelihood that a child will be overweight, and at young ages is a stronger predictor of the child's future obesity risk than the child's own weight (Whitaker et al., 1997). Parents can be powerful agents of change since they influence a child's weight-related behaviors through direct interactions (e.g., the manner in which they feed their child or communicate about health behaviors), via role modeling of healthy behaviors (West et al., 2010), control of the home environment, and establishment of routines. Consequently, family-based interventions are recommended in childhood obesity treatment guidelines (Barlow and Dietz, 1998; Institute of Medicine, 2005) and may improve diet and physical activity in both

children and adults (Golan et al., 1999; Wrotniak et al., 2004). Yet, interventions that specifically address parenting behaviors as a means to achieve these lifestyle goals remain limited. Furthermore, the most efficacious manner to support parents in their role remains unclear (Golley et al., 2011).

Most childhood obesity interventions to date have focused on teaching parents contingency management instruction and exercise/diet guidelines (Connelly et al., 2007; Golley et al., 2011) with less attention to the *process* of parenting (i.e. *parenting style*, the manner in which parents deliver behavioral directives) (Baumrind, 1978). In particular, an authoritative parenting style, (relative to more permissive or domineering parenting styles) has been associated with behaviors that may prevent obesity: increased physical activity (Schmitz et al., 2002), and less food stimuli in the home (Golan et al., 2006). Although general parenting style has not been consistently shown to be associated with *feeding style* (the manner in which parents feed their children), some particular feeding styles, such as using food as a reward

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(instrumental feeding) or to soothe negative emotions (emotional feeding), have been positively associated with child weight (Faith et al., 2004; Gerards et al., 2011).

To support healthy child weight and related behaviors, we are therefore warranted in targeting parenting and feeding styles. To develop an appropriate parenting style, we must first address the parent's own capacity to regulate his or her emotions: an important part of parenting style is whether the parent can maintain a warm and consistent demeanor. Further, the ability to regulate one's emotional experience has broad self-regulatory effects beyond the domain of parenting: it is also associated with aberrant eating (e.g. binge and related emotional eating) and increased body mass. (Buckholdt et al., 2010) Thus, targeting emotion regulation may assist in the mother's ability to role model healthy behaviors. Especially given the demands of parenting young children and managing a household, instruction in emotion regulation, feeding style, and parenting style may help parents both role model and implement behavior change. (Blissett et al., 2010).

KAN-DO (Kids and Adults Now – Defeat Obesity!) is a randomized controlled trial of an intervention designed to promote healthy weight in preschool children. Mothers were recruited soon after the birth of a baby, which may be a critical period (“teachable moment”) and offer a powerful motivational context for promoting behavior change (McBride et al., 2003). The intervention targeted the newborn's older sibling and the mother. The intervention material was delivered via mailed packets, a strategy successfully employed in other family-based interventions (Tilson et al., 2005). This method was chosen due to its potential for broad dissemination (Østbye et al., 2011).

KAN-DO was based on models of affective self-regulation (Bandura, 1986), and behavioral coaches trained mothers to both recognize and address emotional levels (“stepping down the emotional ladder”) before communicating with the family. It also encouraged an authoritative parenting style (Birch and Fisher, 2000; Brody et al., 2002; Kim et al., 2003; Wills et al., 2003; Zucker et al., 2005) as a foundation for lifestyle change. The study's acronym reinforced this by encouraging Kind, Assertive, Neutral, Dependable, and Open-minded (KAN-DO) parenting. Finally, the intervention taught portion control, healthy food options, exercise guidelines, and tips for behavior change in a family with young children (time constraints, fast food, day care, etc.). Consistent with social cognitive theory (Bandura, 1962; Bandura et al., 1963), parental role modeling was hypothesized to facilitate a mutual synergy of healthy mother–child behavior, and was thus emphasized throughout the intervention.

The primary outcomes for the overall KAN-DO study are change in child diet, physical activity, and sedentary behavior from baseline to immediately post-intervention, (hereafter referred to as follow-up 1), and child weight change from baseline to 22 months post-baseline (follow-up 2). Secondary outcomes and potential mediating factors

include change in parenting behaviors, mother's dietary intake and physical activity, and mother and child weight (at follow-up 1). This manuscript presents follow-up 1 primary and secondary outcomes.

Materials and methods

Study population, recruitment, and randomization

The target population was postpartum women who were overweight or obese (NHLBI Obesity Task Force, 1998) prior to pregnancy and their children aged 2–5 years, in the Triangle and Triad regions of North Carolina. Women were primarily identified from state birth certificates and screened for eligibility at 2–6 months postpartum (Østbye et al., 2011). To be eligible, mothers had: a preschooler aged 2–5 years, self-reported pre-pregnancy (and measured postpartum) body mass index (BMI) ≥ 25 kg/m², no medical conditions preventing daily physical activity, English literacy, regular telephone access, and be ≥ 18 years of age.

Eligible and interested dyads attended a baseline assessment. After written informed consent, measurements were taken including standardized height and weight of mother and preschooler. Four hundred dyads were randomized (November 2007–October 2009) with equal allocation to intervention and control arms via permuted 8-block randomization. KAN-DO was approved by the Institutional Review Boards of the Duke University Health System and UNCG and registered with Clinicaltrials.gov (NCT00563264). The design and rationale have been described in detail (Østbye et al., 2011).

Intervention (Fig. 1)

Participants in the intervention arm received 8 monthly mailed interactive kits, followed each month by a 20–30 minute telephone coaching session using motivational interviewing techniques. Kits included child activities and incentives reinforcing the month's topic (e.g., a rewards chart, yoga mat, pedometer, portion plate).

The intervention targeted the dyad's healthy weight via instruction in parenting styles and skills, techniques for stress management (including emotion regulation), and education about healthy behaviors. Parenting skill instruction emphasized 1) an authoritative parenting style, 2) routines for sleep and mealtimes, 3) a supportive home environment, 4) role modeling of healthy eating and physical activity, and 5) improvement of feeding style. Education about healthy behavior changes in the dyad targeted: decreased intake of sugary drinks and fast food, increased fruit and vegetable consumption, meals prepared at home, moderate-to-vigorous physical activity (MVPA), and decreased sedentary behavior.

Coaching calls reviewed information in the module and addressed motivation, self-efficacy, and barriers to change. Consistent with motivational interviewing principles (Miller and Rollnick, 2002), the coaches used reflective listening to elicit goals for behavior changes and stress management. The intervention also included one semi-structured group session, where the study coaches and nutritionist reinforced content from the family kits and set aside time for role play and group discussion. A healthy meal and free child care were provided.

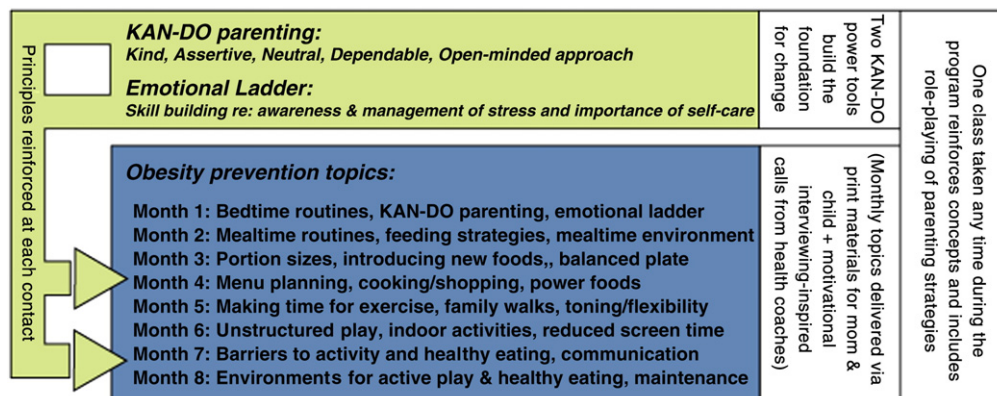


Fig. 1. KAN-DO intervention content.

Control arm participants received monthly newsletters emphasizing pre-reading skills (www.rif.org). Retention was encouraged by monetary incentives (up to \$100 for completion of all assessments). Participants were also asked to provide a locator contact in case they moved or changed phone numbers.

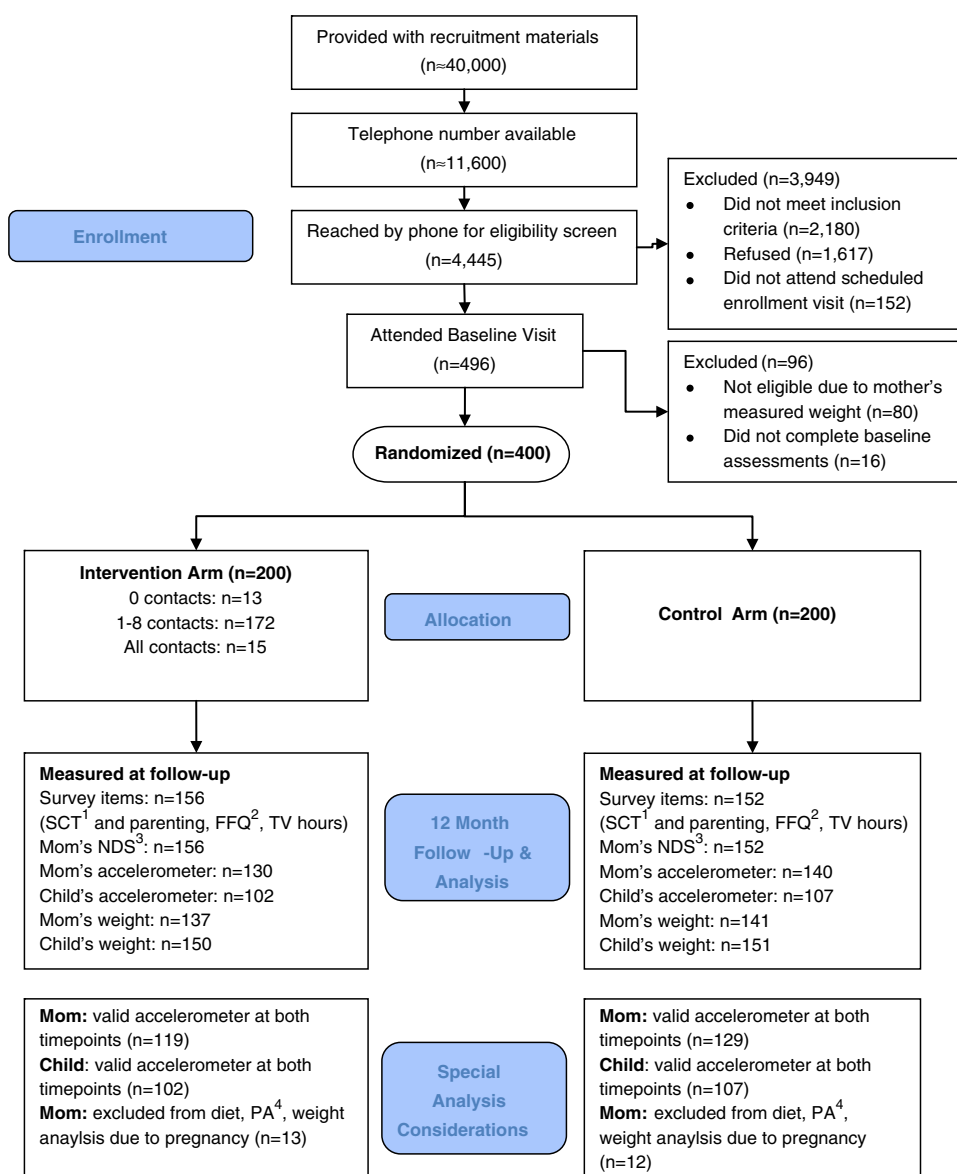
Measures

Assessments were collected at study entry (“baseline” – 2–6 months postpartum) and post-intervention (“follow-up 1”) using validated scales (except where noted). Emotion regulation was measured using the competency subscale of the Parenting Stress Index (PSI) (Abidin, 2004), and parental feeding practices using the Parental Feeding Style Questionnaire (Wardle et al., 2002). The instrumental feeding (“I reward... with something to eat when s/he is well behaved”), emotional feeding (“I give... something to eat to make him/her feel better when s/he is worried”), control (“I decide the times when... eats his/her meals”), and encouragement (“I encourage... to eat a wide variety of foods”) subscales were used to measure change in these behaviors. Home environment changes targeted in the intervention included regular family meals, measured by the Family Meals Questionnaire (Neumark-Sztainer et al.,

2004), television viewing habits (Hesketh et al., 2007), and healthy food availability (“How often do you have healthy snacks/vegetables/fruits in the home?”).

The mother’s daily total energy intake and percent of energy from fat were measured twice following the study visit via a telephone-administered, multiple-pass, 24-hour dietary recall using the Nutrition Data System for Research (2009) (Jonnalagadda et al., 2000; Tran et al., 2000). Mothers reported daily intake of sugary beverages (Dubois et al., 2007; Malik et al., 2006), fast food servings (Bowman and Vinyard, 2004; Bowman et al., 2004), fruits and vegetables (Alinia et al., 2009; Ledoux et al., 2010) for both themselves and their preschoolers; these foods were targets of the intervention given their documented link to obesity, therefore we measured the intake to determine intervention effectiveness.

Physical activity was measured in both preschooler and mother using Actical accelerometers (Klippel and Heil, 2003; Puyau et al., 2002, 2004) (model #198-0200, Mini-Mitter Co. Inc., Bend, Oregon). Data were summarized as minutes of moderate to vigorous physical activity (MVPA) and sedentary behavior. For children, MVPA was defined as ≥ 715 counts/15 s epoch (Pfeiffer et al., 2006), sedentary time as < 12 counts/15 s epoch (Evenson et al., 2008),



¹SCT=Social Cognitive Theory, ²FFQ=Food Frequency Questionnaire, ³NDS= Nutrition Data System, ⁴PA= Physical Activity

Study conducted in the Triangle and Triad regions of North Carolina, U.S.A. 2007–2011.

Fig. 2. KAN-DO study CONSORT flow diagram.

with more than 20 consecutive minutes of zeroes constituting non-wear time. For mothers, MVPA was defined as ≥ 1535 counts/1 min epoch (Colley and Tremblay, 2011), sedentary time as ≤ 50 counts/1 min epoch, with 60 consecutive minutes of zero counts constituting non-wear time. Minimum wear time was set at 6 h/day, and participants must have contributed at least 3 valid days (including a weekend) to be included in the analysis. Time spent watching TV (for both mother and preschooler) was also reported.

Height, in minimal street clothing without shoes was obtained using a Seca portable stadiometer and weight using a Tanita BWB-800 scale. Four percent ($n=13$) of weights at follow-up were self-reported (participant moved away or otherwise unavailable); either measured by a doctor or collected from another calibrated scale ($n=7$) or home scale ($n=6$). Child BMI z-score was calculated to measure relative weight adjusted for age and sex (CDC, 2009).

Intervention participation was indicated by attendance at the group session and completion of coaching calls. Extent and quality of involvement with family kit activities were assessed at calls and through returned postcards (5 questions querying kit content and engagement with child activity; participants were given \$5 for each returned postcard).

Statistical analysis

Mean differences between study arms in change from baseline to post-intervention were assessed on 25 outcomes. Based on 200 participants per arm, the study had 90% power when the true standardized mean arm difference was 0.374. According to Cohen (1988), this effect size is between “small” and “medium”. The logistic regression model was used to test for difference between study arms in number of daily servings of fruits and vegetables (≥ 5 vs. <5) at post-intervention. For all other outcomes, t-tests from general linear models were used to test for mean differences between study arms. Baseline value was used as a covariate in all models. While only participants with follow-up data were used in these analyses, sensitivity analyses were also conducted, in which missing follow-up measurements were imputed to their baseline values.

Given the multiple comparisons presented in the study, the Benjamini–Hochberg (Benjamini and Hochberg, 1995) procedure was used to control the overall 2-sided alpha level at 0.05. Specifically, letting “rank” be the ascending rank order of the 25 observed p-values from highest p-value to lowest, the assigned alpha levels were $0.05 \times (\text{rank}/25)$. Moving from lower to higher rank, as soon as a test was found to be non-significant, all further tests of higher rank were also declared non-significant.

Results

Participant disposition

Of approximately 40,000 women initially identified through state birth records, 400 dyads were randomized into the study (Fig. 2). Of these, 308 completed first follow-up 1 assessments (156: intervention arm; 152: control arm) and were included in these analyses. The excluded 92 women either did not complete follow-up assessments ($n=6$), or were lost to follow-up (refused to participate ($n=11$), could not be reached ($n=50$), did not show-up for scheduled visit ($n=25$)).

Baseline characteristics (Table 1)

About 60% of enrolled mothers were obese ($\text{BMI} \geq 30 \text{ kg/m}^2$), and 25% of preschoolers were already overweight or obese ($\text{BMI} \geq 85\text{th}$ percentile). Seventy-five percent of mothers were white, and 86% were married. Almost 70% had a college or postgraduate education and 57% had a yearly household income above \$60,000. These data are for the full baseline sample ($n=400$). The characteristics of the analysis sample were very similar, but those who completed follow-up were somewhat more likely to be older, married or partnered, more educated, and more affluent than non-completers (data not shown). There were no notable differences between the study arms at baseline.

Table 1

Baseline characteristics of mother–child dyads ($n=400$).

Variable	Intervention ($n=200$) % (n)	Control ($n=200$) % (n)
<i>Child:</i>		
Age (mean = 3.06;SD = 1.0)		
2 years	39.0 (79)	32.5 (65)
3 years	29.5 (59)	36.5 (73)
4 years	19.0 (38)	22.0 (44)
5 years	12.5 (25)	9.0 (18)
Sex		
Male	56.5 (113)	55.0 (110)
Female	43.5 (87)	45.0 (90)
Baseline weight status		
Underweight	4.0 (8)	1.0 (2)
Normal weight	71.0 (142)	76.0 (152)
$\geq 85\text{th}$ – $<95\text{th}$ percentile	15.0 (30)	15.5 (31)
$\geq 95\text{th}$ percentile	10.0 (20)	7.5 (15)
<i>Mother:</i>		
Age		
<30	29.5 (59)	23.0 (46)
30–35	31.0 (62)	40.5 (81)
>35	39.5 (79)	36.5 (73)
Race		
White	74.5 (149)	76.0 (152)
Black	21.5 (43)	22.0 (44)
Other races	4.0 (8)	2.0 (4)
Hispanic ethnicity	5.5 (11)	4.0 (8)
Education		
High school graduate or less	9.5 (19)	13.5 (27)
Some college	21.0 (42)	19.5 (39)
College degree	43.0 (86)	41.0 (82)
Graduate school	26.5 (53)	26.0 (52)
Marital status		
Single/never married	10.0 (20)	6.5 (13)
Living with a partner	3.5 (7)	4.0 (8)
Married	86.0 (172)	87.0 (174)
Separated/divorced	0.5 (1)	2.5 (5)
Household income/year		
Up to \$15,000	9.7 (19)	10.6 (21)
\$15,001–\$30,000	7.7 (15)	10.1 (20)
\$30,001–\$45,000	9.7 (19)	8.5 (17)
\$45,001–\$60,000	15.9 (31)	14.6 (29)
\$60,001 or more	56.9 (111)	56.3 (112)
Parity		
Two children	73.0 (146)	63.0 (126)
Three or more	27.0 (54)	37.0 (74)
Study site		
Duke	67.0 (134)	67.5 (135)
UNC-Greensboro	33.0 (66)	32.5 (65)
Baseline BMI (kg/m^2)		
Overweight (25–29.9)	39.5 (79)	38.5 (77)
Obese class I (30–34.9)	35.0 (70)	29.0 (58)
Obese class II (35–39.9)	13.0 (26)	21.0 (42)
Obese class III (40+)	12.5 (25)	11.5 (23)

Study conducted in the Triangle and Triad regions of North Carolina, U.S.A. 2007–2011.

Follow-up assessments post-intervention

Sixty-eight percent of all participants ($n=273$) completed all follow-up 1 measures. Of these, 19 mothers were pregnant again and 6 had delivered a new baby since baseline; these 25 women were excluded from analyses of mother's dietary intake, physical activity and weight. Fig. 2 shows the number of participants available for analyses of the different outcomes.

Participation

All 200 participants in the intervention arm received the 8 family kit materials, and 188 had at least one intervention contact. They completed a mean of 4.1 of 8 coaching calls, returned 3.3 of 8 postcards, and 46% attended the group class. Participation in any of the intervention components was higher, (but not significantly so), among

women who were older, white, married, and more educated. Participation did not differ by BMI (data not shown).

Change in parenting, home environment, and modeled behaviors (Tables 2 and 3)

In children (Table 2), there were small differences between study arms in dietary intake, but these differences were not significant (sugary beverages, $p = 0.13$; fast food, $p = 0.26$; fruits and vegetables, $p = 0.16$). There were no such differences in physical activity ($p = 0.41$) or sedentary behavior ($p = 0.50$). Change in weight among children was not statistically different between arms ($p = 0.63$).

Mothers (Table 3) in the intervention arm showed an increase in self-rated parenting competency (a measure of emotion regulation) compared to those in the control arm (0.49 vs. -0.09), although this difference was not statistically significant ($p = 0.16$). Mothers in the intervention arm decreased instrumental feeding (using food as a reward, -0.24 vs. 0.01 ; $p \leq 0.001$) and emotional feeding (-0.09 vs. -0.03 ; $p = 0.03$). Child's dinners and snacks eaten in front of the TV decreased more in the intervention arm than in the control arm (-0.69 vs. -0.20 ; $p = 0.01$ for dinners, -0.69 vs. -0.24 ; $p = 0.001$ for snacks). The availability of healthy food in the home improved slightly more in the intervention arm (0.13 vs. 0.05 ; $p = 0.09$). When using the Benjamini–Hochberg procedure to control for multiple comparisons, two of the results (instrumental feeding and snacks in front of the TV) remained significant (p -value < Benjamini–Hochberg alpha level). The results of the sensitivity analyses (not shown), in which missing follow-up measurements were imputed to their baseline values, were consistent with the results presented.

In regard to role modeling, mothers in the intervention arm reduced sugary beverage intake more than mothers in the control arm (-5.78 oz vs. -2.24 oz; $p = 0.03$), and the percentage eating 5 or more servings of fruits and vegetables a day increased (by 8.4% in intervention arm vs. 0.0% in the control arm; $p = 0.04$). Sedentary time decreased slightly among controls, but the arm difference was not significantly when controlled for wear time. Change in maternal weight was not statistically different between arms, and there were no other significant differences in mothers' behaviors.

In exploratory analyses, the effect of participation on mother's and child's weight change was assessed. Mothers who completed at least

half of the possible 16 intervention contacts (completed coaching calls and returned postcards) showed a greater mean change in BMI than those who did not (-0.85 vs. -0.07 ; $p = 0.04$).

Discussion

Making changes to dietary intake and physical activity is challenging at any time; instituting such changes in a home environment with multiple young children may be particularly overwhelming. Mothers of multiple children may face challenges in trying to change unhealthy behaviors and routines that may already be established with older children. Mothers with at least two children were selected due to their relative vulnerability, and the fact that they are often not the targets of intervention studies. While first-time mothers receive increased attention and support from family, friends, and healthcare providers, the degree of support may be significantly reduced for mothers who might be viewed as “experienced.” Given the increased demands of multiple children, convenient strategies such as resorting to fast food meals and using food as a reward may be increasingly likely, while the capacity to attend a live group-based session increasingly challenging. While these considerations added to the uniqueness of the current intervention, it may have decreased overall effectiveness.

Despite this challenging context, KAN-DO resulted in significant improvements in feeding practices, maternal dietary intake (greater reduction in sugary beverage intake and increased consumption of fruit and vegetables), and changes in the home environment (fewer dinners and snacks eaten in front of the television). KAN-DO is the first study demonstrating that changes to parenting behaviors (feeding practices) can be made via a mailed intervention. In the children statistically significant improvements in health behaviors and BMI z-score were not observed. Positive trends were seen in child dietary intake, but not in sedentary behaviors, amount of physical activity, and BMI z-score. These results may be due to limited sample size, or measurement error.

In KAN-DO, mothers were provided with power tools to build skills in emotion regulation. The intervention emphasized that a mother's attempts to improve healthy lifestyles in her home can be more effective when she is better able to adopt and model these behaviors herself (Jahnke and Warschburger, 2008; Snoek et al., 2007). Empirical evidence supports that, in general, individuals are

Table 2
Differences between study arms in change from baseline to immediately post-intervention: Child outcomes^a.

Variable	Intervention		Control		p-Value ^b	Benjamini–Hochberg alpha-level ^c
	Baseline mean (se [*])	Change mean (se)	Baseline mean (se)	Change mean (se)		
<i>Child behaviors</i>						
Dietary intake (FFQ) [I = 156; C = 152]						
Sugary beverages (oz/day)	5.02 (0.77)	− 1.32 (0.59)	4.64 (0.62)	0.69 (1.17)	0.13	0.018
Fast food (per week)	1.17 (0.08)	− 0.19 (0.07)	1.21 (0.08)	− 0.12 (0.06)	0.26	0.030
Fruits and vegetables (≥ 5 vs. <5)	18.7%	3.9%	17.9%	− 0.8%	0.16 ^d	0.022
Accelerometer activity [I = 102; C = 107] ^e						
MVPA min/day	16.75 (1.14)	0.24 (1.0)	15.23 (0.90)	1.68 (0.82)	0.41 ^f	0.040
Sedentary min/day	382.75 (8.73)	3.73 (8.79)	368.29 (7.05)	5.59 (8.52)	0.50 ^f	0.042
Sedentary behavior [I = 156; C = 152]						
TV hours/day (mother-report)	2.00 (0.10)	− 0.23 (0.08)	1.99 (0.09)	− 0.12 (0.08)	0.23	0.028
<i>Weight</i>						
Child [I = 150; C = 151]						
BMI z-score	0.35 (0.08)	0.03 (0.05)	0.47 (0.08)	− 0.02 (0.05)	0.63	0.046

I = intervention, C = control, FFQ = Food Frequency Questionnaire, MVPA = moderate to vigorous physical activity, NDSR = nutrition data system for research. Study conducted in the Triangle and Triad regions of North Carolina, U.S.A. 2007–2011.

^a Lost-to-follow-up excluded.

^b Adjusted only for baseline value of the outcome variable.

^c The p-value needs to be below this alpha level for the difference between the arms to be declared statistically significant.

^d Analyzed with follow-up value as outcome and controlling for baseline value.

^e MVPA was defined as ≥ 715 counts/15 s. epochs, and sedentary time was defined as < 12 counts/15 s. epoch.

^f Controlled for wear time.

Table 3Differences between study arms in change from baseline to immediately post-intervention: maternal outcomes^a.

Variable	Intervention		Control		p-Value ^b	Benjamini–Hochberg alpha-level ^c
	Baseline mean (se*)	Change mean (se)	Baseline mean (se)	Change mean (se)		
<i>Emotion regulation/stress [I = 156; C = 152]</i>						
Parenting competency subscale of the PSI	40.81 (0.37)	0.49 (0.29)	41.04 (0.35)	− 0.09 (0.26)	0.16	0.020
<i>Direct interactions [I = 156; C = 152]</i>						
Parental Feeding Style Quest (PFSQ)						
Instrumental feeding	1.99 (0.05)	− 0.24 (0.05)	2.00 (0.05)	0.01 (0.05)	<0.001	0.002
Emotional feeding	1.42 (0.04)	− 0.09 (0.03)	1.48 (0.04)	− 0.03 (0.04)	0.03	0.008
Control	3.86 (0.05)	0.13 (0.03)	3.86 (0.04)	0.09 (0.03)	0.33	0.032
Encouragement	3.97 (0.04)	0.10 (0.04)	4.01 (0.04)	0.04 (0.04)	0.38	0.036
<i>Home environment measures [I = 156; C = 152]</i>						
Family Meals Questionnaire (FMQ)						
Meals eaten together	6.80 (0.26)	0.21 (0.25)	7.27 (0.26)	0.32 (0.23)	0.23	0.026
TV viewing environment						
Dinner in front of TV	2.47 (0.14)	− 0.69 (0.12)	2.17 (0.14)	− 0.20 (0.11)	0.01	0.006
Snack in front of TV	3.36 (0.13)	− 0.69 (0.13)	3.45 (0.14)	− 0.24 (0.13)	0.001	0.004
Home food environment						
Availability of Healthy Food	4.15 (0.04)	0.13 (0.03)	4.21 (0.04)	0.05 (0.03)	0.09	0.016
<i>Mother (role modeled) behaviors^d</i>						
Dietary intake – (FFQ) [I = 143; C = 140]						
Sugary beverages (oz/day)	15.69 (1.87)	− 5.78 (1.35)	15.35 (1.76)	− 2.24 (1.34)	0.03	0.010
Fast food (per week)	1.53 (0.10)	− 0.36 (0.09)	1.48 (0.10)	− 0.16 (0.08)	0.07	0.014
Fruits and vegetables (≥ 5 vs. <5)	15.4%	8.4%	16.4%	0.0%	0.04 ^e	0.012
<i>Dietary recall (NDSR) [I = 130; C = 139]</i>						
Total kcal/day	2018 (46.38)	− 269 (52.64)	2081 (46.38)	− 257 (47.56)	0.36	0.034
Percent kcal from fat/day	32.3 (0.59)	0.6 (0.7)	32.0 (0.55)	0.1 (0.7)	0.39	0.038
<i>Accelerometer activity [I = 119; C = 129]^f</i>						
MVPA min/day	8.31 (0.71)	2.42 (0.79)	8.08 (0.65)	3.52 (0.91)	0.16 ^g	0.024
Sedentary min/day	530.05 (9.07)	0.19 (8.73)	524.80 (7.40)	− 15.78 (7.34)	0.58 ^g	0.044
<i>Sedentary behavior [I = 143; C = 140]</i>						
TV hours/day (self-report)	2.22 (0.10)	− 0.35 (0.09)	2.21 (0.10)	− 0.34 (0.09)	0.91	0.050
<i>Weight</i>						
Mother [I = 137; C = 141]						
BMI	32.42 (0.44)	− 0.65 (0.18)	32.55 (0.44)	− 0.57 (0.15)	0.77	0.048

I = intervention, C = control, FFQ = Food Frequency Questionnaire, MVPA = moderate to vigorous physical activity, NDSR = nutrition data system for research.

Bold entries denote results that remain significant when controlling for multiple comparisons using the Benjamini–Hochberg procedure. Study conducted in the Triangle and Triad regions of North Carolina, U.S.A. 2007–2011.

^a Lost-to-follow-up excluded.^b Adjusted only for baseline value of the outcome variable.^c The p-value needs to be less than this alpha level for the difference between the arms to be declared statistically significant.^d Pregnant/live birth at follow-up (n = 25) excluded for mother's dietary intake, PA, and weight.^e Analyzed with follow-up value as outcome and controlling for baseline value.^f MVPA was defined as ≥1535 counts/1 min epoch and sedentary time was defined as <50 counts/1 min epoch.^g Controlled for wear time.

more accurate at perceiving the motivations of others when they are more accurate at perceiving their own motivations, including emotional experience (Prkachin et al., 2009). From this perspective, the observed reductions in emotional feeding may reflect that mothers' improvement in their ability to recognize their own emotions may have helped them differentiate hunger from emotion in their children. Such changes may establish a foundation for improved self-regulation in the child. Further, when fed in response to emotional stimuli rather than to biological hunger, children may learn to confuse physiological responses of emotion (e.g. "butterflies in the stomach") with hunger. Future research should more systematically examine the impact of changes in emotional feeding on the development of self-regulatory capacities in children.

Reductions in instrumental feeding may also reflect improvements in the mother's ability to manage her child's behavior without resorting to food rewards. Food is inherently rewarding as it satiates biological hunger (van den Bos and de Ridder, 2006). Thus, when the mother instrumentally feeds her child (i.e., offers food as a reward), she increases

the value of something already perceived to be valuable. Whether reductions in instrumental feeding can impact responsivity to food cues in vulnerable children is also an interesting area for further study.

Through role modeling, changes in maternal behavior may likewise have "downstream" effects on child behavior. It is easier to develop healthy behaviors than to alter unhealthy habits. Thus, it is promising that mothers decreased consumption of sugar-sweetened beverages and increased intake of fruits and vegetables. Positive changes in maternal behavior imply that the child is exposed to adaptive behavior that can guide his or her own decisions, and unhealthy foods may be less available in the home (Golan, 2006).

Prior interventions differ in several respects from KAN-DO in terms of developmental stage of the study participants, mode of intervention delivery, and sample size. For example, the UK Families for Health trial (Robertson et al., 2008) addressed parenting and emotional regulation in older children, via live parallel groups of parents and adolescents (total sample only 27 individuals). Similar to the current study, improvements were observed in exposure to unhealthy foods,

and, while not directly comparable to KAN-DO, improvements were also seen in child quality of life, sedentary behavior, and parent mental health. Golley et al. (2007) demonstrated the value of parenting skills in the context of an obesity intervention for 5–9 year olds ($n=110$). The parenting skills intervention resulted in a 5% reduction in BMI.

Strengths and limitations

KAN-DO's strengths include the relatively large sample size, the unique developmental stage that was targeted, and the racial and economic diversity of the sample. Despite this diversity, the women who enrolled tended to be highly educated, and a high proportion were married. The mode of delivery provided insights into the amount and intensity of intervention needed to promote behavior change. Yet, the design strategy may have limited the impact of the intervention as change in important domains of health behavior could not be shown. The standardized assessment was comprehensive; this was both a strength and a weakness: while it attempted to capture a broad spectrum of factors that may evidence change, it also resulted in a large number of statistical comparisons, and potentially high participant burden. The findings may also be limited by the fact that many outcomes are based on self-reported measures.

Implications and conclusions

While parents have long been regarded as critical in the prevention of childhood obesity, the best way to integrate parents and facilitate dyadic change remains unclear. The KAN-DO intervention builds on the small, but growing, body of work incorporating parenting practices into obesity interventions.

KAN-DO was an ambitious trial; women at a challenging time in their lives, soon after the birth of a new baby, were approached to take part in a fairly complex intervention together with their preschoolers. Its development was guided by a desire to find the type and intensity of an intervention that is comprehensive, but not so elaborate as to prohibit dissemination. Thus, the resulting intervention was designed to be reasonable for mothers of young children. It appears to have been appropriate as evidenced by the high level of interest; however, enrollment, as well as full participation among those enrolled, was difficult, especially for women at lower socioeconomic levels, who may be most in need of intervention. This is consistent with the few earlier studies of public health interventions targeting similar at-risk dyads (Golley et al., 2007; Robertson et al., 2008; West et al., 2010). Future studies should investigate alternative methods of delivery (e.g. mobile technologies) to assist new mothers in getting the ongoing support and information they need. Yet, it is still plausible that the intervention dose received in KAN-DO, and the resulting improvements in feeding practices, maternal dietary intake, and home environment will lead to a healthier future for these young children.

Conflict of interest statement

The authors have no conflicts to report.

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