Published in final edited form as:

Matern Child Health J. 2014 July ; 18(5): 1246–1257. doi:10.1007/s10995-013-1359-x.

Preventing obesity in infants and toddlers in child care: Results from a pilot randomized controlled trial

Sara E Benjamin Neelon, PhD, MPH, RD,

Department of Community and Family Medicine, Duke University Medical Center and Duke Global Health Institute, 2200 W Main St, DUMC 104006, Durham, NC 27705, sara.benjamin@duke.edu

Elsie M Taveras, MD, MPH,

Obesity Prevention Program, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, 133 Brookline Ave, 6th floor, Boston, MA 02215, elsie_taveras@harvardpilgrim.org

Truls Østbye, MD, PhD, and

Department of Community and Family Medicine, Duke University Medical Center and Duke Global Health Institute, 2200 W Main St, DUMC 104006, Durham, NC 27705, truls.ostbye@dm.duke.edu

Matthew W Gillman, MD, SM

Obesity Prevention Program, Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, 133 Brookline Ave, 6th floor, Boston, MA 02215, matthew_gillman@harvardpilgrim.org

Abstract

Objective—Few interventions have focused on very young children for obesity prevention. This study evaluated a pilot intervention to improve the nutrition and physical activity environments of child care centers serving infants and toddlers.

Methods—This randomized controlled trial took place in 32 centers in Boston, Massachusetts. The intervention aimed to improve policies and practices related to nutrition and physical activity within the center. For the outcome, observers assessed center environments using the Environment and Policy Assessment and Observation (EPAO) instrument (range 0–320 points) at baseline and the six-month follow-up. We fit linear regression models with change in EPAO score from baseline to follow-up, controlling for potential confounders for total score, nutrition sub-score, and physical activity sub-score.

Results—Intervention centers had a mean (SD) of 98.2 (144.8) children enrolled, while control centers had 59.2 (34.5). In intervention centers, 47.5% of children were white, compared to 46.2% in controls. Fewer intervention centers had outdoor play areas on site (75% vs. 100%) but more had indoor play space (67% vs. 25%). At baseline, intervention centers had a mean (SD) EPAO

score of 134.5 (7.0) points and controls had 146.8 (4.8) points. Compared with controls, intervention centers improved their EPAO scores at follow-up by 18.5 points (95% CI 0.1, 37.0; $p=0.049$), chiefly through greater improvement in physical activity (12.2; 95% CI -1.6, 26.0; $p=0.075$) and not nutrition (6.4; 95% CI -7.1, 19.8; $p=0.385$).

Conclusions—The pilot showed promise as an intervention to improve center environments, but future studies should include child-level outcomes.

Keywords

Child care; infant; nutrition; physical activity; toddler

Introduction

Obesity presents a substantial health problem, even for very young children. In recent years, United States (US) data show that nearly one out of ten children ages 0 to 23 months has a weight-for-length at or above the 95th percentile [1-3]. Obesity and excessive weight gain in the first year of life are both associated with higher blood pressure [4, 5], wheezing [6], and other adverse health conditions in childhood [7]. Heavier infants and infants who gain weight more quickly in the first year of life are more likely to be obese later in childhood [8, 9].

Obesity affects children from racial and ethnic minority groups disproportionately, and rates are increasing more rapidly among American Indian [10], African-American, and Hispanic/Latino(a) children than in white children [11]. These racial and ethnic disparities are evident in the first few years of life. Early life obesity risk factors, including excessive weight gain in infancy, lower rates of exclusive breastfeeding, and poor dietary intake are more common by age four years among African-American and Hispanic/Latino(a) children than among white children [12]. Early intervention, especially for racial and ethnically minority children, may reduce the risk of obesity later in life. But, few interventions have targeted very young children, particularly children under two years of age, for obesity prevention.

An important target for obesity prevention in young children may be the child care setting [13, 14]. In recent decades, greater numbers of parents have turned to child care providers to help care for their infants and toddlers. In 2002 in the US, 42% of children less than one year of age and 53% of children ages one to two years were cared for by someone other than a parent at least one day per week [15]. Although child care programs serve as important settings for shaping life-long behaviors, providers receive little guidance in creating healthy environments to prevent and reduce obesity. Recent studies suggest that children who attend child care are more likely to be obese than children cared for at home by a parent or other caregiver, and children of younger ages might be those at highest risk [16-18]. Our own research found that infants who spent time in child care during the first six months of life, especially in less formal care settings, were heavier at one year and still heavier at three years of age [18]. Obesity prevention interventions in infants and toddlers have been designed for delivery in home [19-23], community [24, 25], and clinical settings [26-29]. However, few have targeted child care for intervention. The objective of this study was to

test the ability of an intervention targeting children less than two years of age and their care providers to enhance the nutrition and physical activity environments of child care centers.

Methods

Trial Design and Participants

For this pilot study, we conducted a randomized controlled trial (RCT) in a sample of centers serving racially and ethnically diverse children less than two years of age. We present information about the study in accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines [30]. This six-month-long intervention took place from spring to fall 2009 in 32 licensed centers located in greater Boston, Massachusetts (MA). Centers were eligible to participate if they were located in the Boston area, if the MA licensing office classified them as a center and not a family child care home, if at least 50% of children in care were racial minorities (non-white), and if the center served both infants and toddlers. We excluded centers from participation if they had an open case of abuse or neglect on file with the state. We worked with the MA Child Care Resource and Referral agency to generate a list of all eligible centers in Boston, and in random order called 76 centers to invite them to participate in the study. We mailed interested centers a description of the intervention, and 32 agreed to participate. This was a convenience sample of centers, with the total number determined by available funding rather than a power calculation. The study coordinator enrolled centers into the study. We obtained written informed consent from each center director prior to the onset of the study. Since we did not collect any identifying information about the children in care, we obtained consent from the director only and not the parents of individual children. We did not make any changes to the methods after the trial had commenced. The research was conducted in accord with prevailing ethical principles; the Human Subjects Committee of Harvard Pilgrim Health Care approved this study.

Intervention

We designed the Baby Nutrition and Physical Activity Self-Assessment for Child Care (Baby NAP SACC) intervention to improve policies and practices in child care to help prevent obesity in children less than two years of age. The intervention allowed centers to assess their nutrition and physical activity environments, select areas for improvement, and make changes with the help of a trained interventionist. The Baby NAP SACC intervention was based on the Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) intervention, which targeted children two to five years of age in child care [31-33]. The Baby NAP SACC intervention focused on four nutrition areas, three physical activity areas, and one overall center environment area, with a total of 47 specific behavioral targets (Table 1).

The specific needs of infants and toddlers can be quite different for both feeding and physical activity, although some common themes emerged. For example, the Baby NAP SACC intervention encourages providers to respect children's hunger and satiety cues. However, in practice, this may be manifested differently. The intervention encourages providers to learn to recognize hunger cues in infants—noting differences between crying

out of hunger and crying due to discomfort or some other reason. Additionally, the intervention discourages practices like bottle propping, which may prevent an infant from turning away from the bottle and also represents a choking hazard. Additionally, the nutritional needs of infants and toddlers are quite different, given the major milestone that happens when infants turn 12 months of age and transition from human milk or formula to cow's milk. Thus, the nutrition target areas for infants were quite different from those for toddlers.

For physical activity, the needs of infants and toddlers are somewhat similar, in that all children should have the opportunity to move about freely both inside and outdoors. The Baby NAP SACC intervention helps providers encourage activity in infants by allowing them to move freely on a safe and clean surface within the center, engaging with them on the ground, and supporting them as they creep, crawl, and reach for objects. Also, many infants are taking outdoors, but restricted to a stroller or infant carrier. The intervention encourages providers to allow infants to spend time outside and unrestricted. For toddlers, increasing physical activity may mean providing indoor and outdoor play space that is separate from older children to help promote active play and prevent injury. It also means engaging with toddlers to make physical activity fun and engaging.

Like NAP SACC, the Baby NAP SACC intervention included a self-assessment instrument [34] consisting of 37 nutrition questions and 20 physical activity questions based on the eight intervention target areas. We developed the self-assessment using current research literature and available standards and recommendations related to infant feeding, healthy eating, and physical activity [35-44]. Each question had four response categories, assigned one, two, three, or four points (one=below standard, two=minimum standard, three=good, four=best practice). The selfassessment was an intervention instrument, designed to highlight the best practice response and thus spark change in intervention centers at the onset of the study. Built around the selfassessment, the intervention consisted of five steps: 1) self-assessment; 2) action planning; 3) technical assistance; 4) training; and 5) re-assessment. All intervention directors completed the self-assessment instrument at the onset of the study. Trained interventionists worked with directors to choose four targets areas (two nutrition and two physical activity) for improvement and to create an action plan to make these changes. Interventionists encouraged centers to select behavioral targets with the lowest scores on the baseline self-assessment—those with the greatest room for improvement. The centers implemented changes during the six-month-long intervention period with ongoing technical assistance provided at least monthly by the interventionist. During technical assistance visits, the interventionists helped centers make and sustain changes related to the areas they selected for improvement through training, research, and intervention materials focused on the behavioral targets. During months two through four of the intervention, the interventionist delivered two workshops to center staff focused on infant and toddler feeding and physical activity. While all staff members were invited to the workshops, the workshops targeted the center director, the food preparer, and the infant and toddler room teachers. At the end of the intervention, center directors completed a follow-up self-assessment to evaluate changes made, revise goals, and repeat the process for continued environmental improvement. However, this self-assessment was not an outcome measure.

Of the two interventionists, one had an MPH degree in health education, while the other had a BS degree in Nutrition and was also a certified athletic trainer. The interventionists went through a four-week training on nutrition and physical activity for infants and toddlers that included specialized readings, workshops, and individualized training from a Registered Dietitian with extensive experience with NAP SACC and in child care. All intervention activities were supervised by the Registered Dietitian, who provided regular feedback and support to the interventionists.

Outcomes

We assessed each center's environment using the Environment and Policy Assessment and Observation (EPAO) [45] instrument in the spring (baseline) and fall (follow-up) of 2009. The EPAO assessed child care nutrition and physical activity environments, policies, and practices, and was developed by Ward and colleagues using the standards, recommendations, and research literature upon which the NAP SACC intervention was based [31]. The EPAO protocol and information about inter-rater reliability from testing in child care centers are reported elsewhere [45]. Briefly, the EPAO consisted of eight nutrition domains, including 1) Fruits and Vegetables, 2) Grains, 3) High Sugar, Salt, and Fat Foods, 4) Beverages, 5) Nutrition Environment, 6) Nutrition Staff Behaviors, 7) Nutrition Education, and 8) Nutrition Policies. Physical activity domains include 1) Active Time, 2) Sedentary Time, 3) Sedentary Environment, 4) Physical Activity Environment, 5) Play Equipment, 6) Physical Activity Staff Behaviors, 7) Physical Activity Education, and 8) Physical Activity Policies. The EPAO was developed to assess environments of centers serving children one to five years of age. Thus, we modified nine questions to be relevant for infants. Per EPAO protocol, we converted each question to a three-point scale (zero, one, and two) and totaled scores within a given domain, for a total of 20 possible points per domain. We summed scores for each domain to calculate a total EPAO score (0-320 points), made up of a nutrition sub-score (0-160 points) and physical activity sub-score (0-160 points).

A trained data collector, blinded to treatment group, visited each intervention and control center to conduct the EPAO at the beginning and end of the intervention. Prior to the onset of the study, training for data collectors included an intensive two-day workshop on observation techniques, a mock observation, two practice sessions in a center, and then certification in a center with a gold standard trainer. Data collectors needed to have an overall agreement of 90% with the gold standard reviewer on the EPAO in order to be considered certified. Inter-rater reliability among the data collectors was 0.87 at the final certification. The data collectors focused primarily on the toddler classroom within the center for most of the observation, but spent enough time in the infant classroom to observe all behaviors and answer all EPAO questions related to infants. They also assessed the overall center environment, including an evaluation of indoor and outdoor play areas, and any space set aside for breastfeeding mothers. We did not collect identifying information about individual children; we focused on the child care environment, as well as interaction between providers and the children in their care. We did not make any changes to the outcomes measures after the trial had commenced.

Other Measures

We assessed several center covariates reported by directors, including years in operation, number of staff members, number of children enrolled, and number of income-subsidized children enrolled. Directors also reported participation in the Child and Adult Care Food Program (CACFP), a federal food assistance program that provides reimbursement for eligible meals and snacks served to low-income children in child care. Directors reported their own education levels (high school graduate or some college; college degree; some graduate training or graduate degree) and race and ethnicity (black; white; other), as well as the races and ethnicities of the children in care. Directors reported on the presence of indoor and outdoor play space available to children in care. Finally, at the end of the study, intervention directors were asked to rate their satisfaction level (not at all satisfied, somewhat satisfied, satisfied, very satisfied) with their participation in the intervention and whether or not they would recommend the intervention to other directors.

Randomization

We used a computer-generated random allocation sequence to assign centers to the intervention or control group on a 1:1 ratio after baseline assessments had been completed. This process was managed by a biostatistician and each allocation was communicated to the study coordinator via sealed, sequentially numbered opaque envelopes.

Blinding

Trained data collectors who conducted the EPAO at centers and study investigators were blinded to treatment group and study hypotheses throughout the study. The Principal Investigator, study coordinator, interventionists, center teachers, and center directors were not blinded to treatment group.

Analysis

We computed baseline means and standard deviations (SD) for continuous demographic variables and frequencies for categorical variables. To assess differences between groups in these baseline characteristics, we conducted Wilcoxon rank-sum tests for continuous variables and exact Pearson chi-square tests for categorical variables. The analysis used data from all intervention and control centers, including the four intervention and two control centers that started, but did not complete the study. We considered each center to be a single participant because we did not perform measurements on individual children. For the main outcome, we calculated total score on the EPAO instrument, and secondarily examined nutrition sub-scores and physical activity sub-scores. To compare the change in baseline to follow-up EPAO scores between the intervention and control groups, we fit a linear regression model with change in total score from baseline to follow-up as the outcome, with intervention group as the primary independent variable of interest, with and without adjustment for covariates. We adjusted for covariates of *a priori* interest (child race, number of subsidized children in care) as well as presence of an indoor play area due to differences at baseline. We conducted the same analysis for nutrition sub-score and physical activity sub-score on the EPAO. We did not conduct any interim analysis (e.g., mid-way through the study). We report results in terms of regression estimates, 95% confidence intervals (CI) and

two-sided p-values. We performed all analyses using SAS version 9.1 (SAS Institute, Cary, NC).

We also conducted an exploratory analysis for each EPAO domain, comparing the mean change from baseline to follow-up among centers that selected that particular target area (linked to an EPAO domain) as one of their targets for the intervention, called “interveners”. We compared interveners to all other centers, including intervention centers that did not select the target area plus all control centers, called “non-interveners”. Thus, “non-interveners were all control centers combined with intervention centers that did not select that particular area for improvement. We fit a mixed-effects linear regression model with domain score as the outcome. Independent variables included an indicator for each domain, an indicator for study period (baseline or follow-up), a group indicator (intervener vs. non-intervener), domain by period interaction terms, domain by group interactions, and domain by period by group interactions. The effect of interest is the three-way interaction between domain, period and group, which measures the difference in change scores between groups for each domain (i.e., a “difference of differences” for each item). For each domain, we obtained a change score for interveners, a change score for non-interveners and a difference of difference estimate comparing the groups. We report these results in terms of covariate-adjusted regression estimates and 95% CI separately for interveners and noninterveniers, plus the differences between these two; and p-values from a 14-degree of freedom F test to evaluate the overall group effect across all domains.

Results

We enrolled 32 child care centers: 16 intervention and 16 control. During the course of the study, three intervention centers and two control centers withdrew. Of the three intervention centers that withdrew, one director cited health issues as her reason for withdrawing, one did not have time for the intervention, and one did not provide a specific reason for withdrawing. One control center director stated that parents were not supportive of their participation in a research study and a second said that she did not have time to participate in the study. An additional intervention center went out of business, leaving 12 intervention and 14 control centers that completed the follow-up assessments at six months. A comparison of demographic variables at baseline between centers who withdrew from the study and those who completed the study did not show differences (data not shown). We did not receive any reports of harm or unintended effects of the intervention from any intervention or control centers. Baseline characteristics of centers are presented in Table 2. Intervention centers had an average and standard deviation (SD) of 98.2 (144.8) children and control centers had 59.2 (34.5) children enrolled at baseline. However, the total number of infants (6.6 (5.0) vs. 6.4 (4.8)) and toddlers (10.1 (7.1) vs. 8.1 (5.7)) did not differ between intervention and control centers. Intervention centers also had more income-subsidized children enrolled than controls (38.4 (84.9) vs. 20.2 (28.2)), which means they had greater numbers low-income children in care. Intervention centers also had fewer outdoor play areas on site (75% vs. 100%) but more had indoor play areas (67% vs. 25%), compared to control centers. Nearly half of the children in intervention and control centers were white (47.5% in intervention and 46.2% in control centers).

Each intervention center directors selected two nutrition and two physical activity areas for improvement; these selections varied and were spread across all nutrition and all physical activity domains with one exception. A number of centers opted to improve the nutritional quality of the foods provided to children, focusing on limiting fried foods like french fries, fish sticks, and chicken nuggets. Other centers selected beverages for improvement, and limited the amount of juice provided to both infants and toddlers, and decreased sugar-sweetened beverages and increased water for toddlers. Some centers focused on behaviors among staff associated with interactions with children around feeding. For example, one center stopped encouraging toddlers to clean their plates and discussed the importance of identifying and respecting the satiety cues of young children. Another center provided a designated place for mothers to breastfeed that was not a bathroom. A few centers instituted regular training in physical activity for staff members, through their local health department. Another center subsidized gym memberships for staff to help encourage their personal health and promote their physical activity. None of the center directors selected the nutrition policies or physical activity policies domain for intervention. Table 3 shows center EPAO scores at baseline and at the six-month follow-up by group assignment for the 12 intervention and 14 control centers. At follow-up, EPAO score had increased by a mean of 12.8 points in the intervention group and decreased by 4.2 points in the control group, resulting in a crude difference of 17.0. After multivariable adjustment for child race, number of subsidized children in care, and presence of an indoor play area, and compared with control centers, in linear regression models, intervention centers increased their total EPAO scores from baseline to follow-up (18.5 difference; 95% confidence interval (CI), 0.13, 36.94; $p=0.049$). Also in linear regression models, we observed different results for the EPAO nutrition sub-score (6.4 difference; 95% CI, -7.12, 19.83; $p=0.385$) and EPAO physical activity sub-score (12.2 difference; 95% CI, -1.64, 26.01; $p=0.075$).

For the exploratory analyses using the mixed-effects linear regression model, we present mean change score for interveners, a change score for non-interveners and a difference of difference estimate comparing the groups (Table 4). Note that two domains, nutrition policies and physical activity policies, were not selected for intervention by any center; hence there is no estimate for the intervener group for these two domains. Consequently, the overall F test has 14 degree of freedom rather than 16. Centers that withdrew from the study were not included in this analysis. Domains that contributed the most to overall change in nutrition sub-score include high sugar, high salt, and high fat foods, with a mean (SD) adjusted difference of 21.0 (9.5, 32.4) points ($p=0.0003$) and nutrition staff behaviors (9.8 (2.9, 16.7) $p=0.005$). For the physical activity domain, sedentary time (8.3 (1.4, 15.1) $p=0.02$), physical activity environment (9.9 (1.7, 18.1) $p=0.02$), and physical activity staff behaviors (16.5 (1.0, 12.1) $p=0.02$) were the primary domains contributing to improved EPAO sub-score. Results from the overall F test show an overall group effect across all domains ($p<0.0001$).

Based on follow-up questions of the 12 intervention directors, 92% reported being “satisfied” or “very satisfied” with the Baby NAP SACC intervention and 83% reported they would recommend the intervention to other center directors.

Discussion

This Baby NAP SACC pilot study is the first intervention study designed to change the nutritional and physical activity environments of child care centers serving infants and toddlers. While the adjusted difference of 18.5 points in EPAO total score was significant, the wide confidence interval (0.13 to 36.94) cautions against making strong inferences. In the nutrition and physical activity sub-scores of the EPAO, we found that intervention centers showed more improvement in their physical activity sub-score (adjusted intervention-control difference of 12.2 points) than nutrition sub-score (6.5 points). This finding is different from results found in the NAP SACC intervention trial among slightly older children, which showed pre- to postintervention changes in nutrition but not physical activity sub-score [33].

When we examined specific nutrition and physical activity domains within the EPAO, we found that the high sugar, high fat, and high salt foods domain, as well as the nutrition staff behaviors domain, contributed most to the overall change in nutrition sub-score. For physical activity, the sedentary time, physical activity environment, and physical activity staff behaviors domains appeared to have influenced the physical activity change sub-score. Staff behaviors related to both nutrition and physical activity were the two domains affected the most. This finding suggests that centers are willing to make improvements in staff/child interactions around feeding and physical activity. These behaviors might be easily modified with training or feedback from directors to providers. Staff behavior changes may be low cost ways to improve nutrition and physical activity practices within child care, whereas some of the other domains might require a financial investment for improvement, such as serving fruit instead of fruit juice.

A handful of previous intervention studies have targeted child care. Hip-Hop to Health Jr. was designed to promote healthy eating and prevent obesity in racially and ethnically diverse children ages three to five years. The intervention was successful in controlling excess weight gain in African-American children attending 12 Head Start centers in Chicago [46]. Saturated fat intake was lower in children attending intervention centers at one year follow-up, but not two years. In a second study of centers serving predominantly Latino(a) children, the authors did not find significant differences in either outcome [47]. A quasi-experimental study in Australia (Romp and Chomp) found lower prevalence rates of obesity in two-year-old children attending family child care homes than in the comparison settings [48, 49]. The Munch and Move intervention [50], also in Australia, was an RCT in 15 intervention and 14 control preschools. Children in the intervention improved their movement skills and parents enhanced the nutritional content of their lunch boxes at the end of the intervention [50]. Additionally, The Melbourne Infant Feeding, Activity and Nutrition Trial (InFANT) Program is a cluster-randomised controlled trial in 492 families. The goal is to prevent obesity in infants ages 4-20 months. The intervention showed positive effects on some of the dietary outcomes of interest and children's television viewing [51]. Another intervention targeting children, parents, and child care providers in six Head Start centers in the U.S. found a reduction in body mass index among both children and adults in the intervention centers [52]. It is challenging, however, to make comparisons across these studies due to varying outcomes and study designs. The Baby NAP SACC intervention is

the first, to our knowledge, to focus exclusively on younger children in child care—infants and toddlers who may be most at risk for the development of obesity [16-18].

This study has limitations. We tailored the intervention to the needs of individual centers—centers selected areas for improvement based on their interests. In this “a la carte” approach we would not expect centers to show substantial improvement on all eight nutrition or all eight physical activity EPAO domains, thus making it difficult to detect a strong overall intervention effect. Nevertheless, our findings suggest a slight difference between groups, but a more comprehensive trial is indicated to sufficiently test the intervention. First, the trial must incorporate more centers to allow for robust analysis by group. Second, measuring child-level behaviors and anthropometric outcomes is important. Third, insisting that all intervention centers intervene on the same target areas, selected a priori by the study team, has pros and cons.

Although self-selection may increase participant engagement, which informed our decision to use the approach in both NAP SACC and the Baby NAP SACC pilot, it is likely that this also reduced our ability to detect intervention effects. Finally, we modified the EPAO to include questions appropriate to measure infant environments. Thus, these alterations likely affected validity and reliability. Although the changes were minor, future studies should evaluate how these changes affected the instrument.

Since this study focused on a specific city in New England, results may not be generalizable to child care centers in other cities or other states across the US. Using the information gleaned from this pilot study, however, we are set to launch a larger trial in 80 child care centers, 640 children, and their families in late 2013. This intervention will target both the center and the family home environment in order to affect the two primary settings where children spend time and include child-level outcomes.

This study differs from NAP SACC in that the interventionist who delivered the Baby NAP SACC intervention were not nurses employed by the county health department. Instead, we hired and trained interventionists who were employed by Harvard Medical School, which allowed us to have greater control over the delivery of the intervention. A limitation of this approach is that we did not test the effectiveness of the intervention to improve center environments when delivered through existing public health infrastructure. Instead, we tested the efficacy of the intervention delivered through trained interventionists employed by the researchers. The Baby NAP SACC study was also different from NAP SACC in that interventionists encouraged centers to select two nutrition and two physical activity areas that had some room for improvement. In the NAP SACC intervention, centers selected one nutrition and one physical activity area, and a third area from either category. Centers were encouraged to select any areas for improvement, even if they scored well in that area on the baseline selfassessment. Additionally, longer-term outcomes of the NAP SACC and Baby NAP SACC intervention have not been assessed. Previous evaluation studies have assessed outcomes at the end of the six-month-long intervention, but researchers have not returned to assess the sustainability of change.

Another limitation of this study was our inability to track the participation of infant and toddler teachers in the workshops and other intervention activities. In fact, we do not know the extent to which teachers were exposed to the intervention, or if the same teachers were still present and employed at the center at the end of the intervention. A final limitation is that we did not account for temperature or season during our outcome assessment. Given the potential influence of weather on physical activity, and season on food availability, future studies should document and perhaps control for season in the analysis of outcome data.

Conclusions

Although the first few years of life are critical for the development of obesity, only a handful of interventions have targeted children in child care for obesity prevention [32, 33, 46-54]. Of those, most have focused on preschoolers. The Baby NAP SACC intervention shows promise as an innovative approach to promoting healthy child care environments for infants and toddlers, but more rigorous testing is needed to determine its effects on child adiposity and to evaluate its potential for wide-scale dissemination.

Acknowledgments

The authors would like to thank Arielle Traub and Lauren Bradley for their assistance with data collection; Sarah Ball for her help reviewing the literature; and Katrina Krause, Brian Neelon, and Ken Kleinman for their analytic support. This study is registered in the International Standard Randomised Controlled Trial Number Register: ISRCTN33733318. This study was supported, in part, by National Institutes of Health grant F32DK80618.

References

1. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of High Body Mass Index in US Children and Adolescents, 2007-2008. *Journal of the American Medical Association*. 2010; 303:242-249. [PubMed: 20071470]
2. Kim J, Peterson KE, Scanlon KS, et al. Trends in Overweight from 1980 through 2001 among Preschool-Aged Children Enrolled in a Health Maintenance Organization. *Obesity*. 2006; 14:1107-1112. [PubMed: 16899790]
3. Ogden CL, Carroll MD, Kit BK, et al. Prevalence of obesity and trends in body mass index among us children and adolescents, 1999-2010. *Journal of the American Medical Association*. 2012; 307:483-490. [PubMed: 22253364]
4. Huxley RR, Shiell AW, Law CM. The role of size at birth and postnatal catch-up growth in determining systolic blood pressure: a systematic review of the literature. *Journal of Hypertension*. 2000; 18:815-831. [PubMed: 10930178]
5. Belfort MB, Rifas-Shiman SL, Rich-Edwards J, et al. Size at birth, infant growth, and blood pressure at three years of age. *Journal of Pediatrics*. 2007; 151:670-674. [PubMed: 18035150]
6. Taveras EM, Rifas-Shiman SL, Camargo CA Jr, et al. Higher adiposity in infancy associated with recurrent wheeze in a prospective cohort of children. *Journal of Allergy and Clinical Immunology*. 2008; 121:1161-1166. e1163. [PubMed: 18466784]
7. Shibli R, Rubin L, Akons H, et al. Morbidity of overweight ($\geq 85^{\text{th}}$ percentile) in the first 2 years of life. *Pediatrics*. 2008; 122:267-272. [PubMed: 18676542]
8. Baird J, Fisher D, Lucas P, et al. Being big or growing fast: systematic review of size and growth in infancy and later obesity. *British Medical Journal*. 2005; 331:929. [PubMed: 16227306]
9. Monteiro PO, Victora CG. Rapid growth in infancy and childhood and obesity in later life--a systematic review. *Obesity Reviews*. 2005; 6:143-154. [PubMed: 15836465]
10. Anderson SE, Whitaker RC. Prevalence of obesity among US preschool children in different racial and ethnic groups. *Archives of Pediatric and Adolescent Medicine*. 2009; 163:344-348.

11. Wang Y, Beydoun MA. The Obesity Epidemic in the United States—Gender, Age, Socioeconomic, Racial/Ethnic, and Geographic Characteristics: A Systematic Review and Meta-Regression Analysis. *Epidemiologic Reviews*. 2007; 29:6–28. [PubMed: 17510091]
12. Taveras EM, Gillman MW, Kleinman K, et al. Racial/Ethnic Differences in Early-Life Risk Factors for Childhood Obesity. *Pediatrics*. 2010; 125(4):686–95. [PubMed: 20194284]
13. Benjamin Neelon SE, Briley ME. Position of the American Dietetic Association: Benchmarks for Nutrition in Child Care. *Journal of the American Dietetic Association*. 2011; 111:607–615. [PubMed: 21443997]
14. Larson N, Ward DS, Neelon SB, et al. What Role Can Child-Care Settings Play in Obesity Prevention? A Review of the Evidence and Call for Research Efforts. *Journal of the American Dietetic Association*. 2011; 111:1343–1362. [PubMed: 21872698]
15. Johnson, J. Who's minding the kids? Child care arrangements. Spring 2010. U.S. Census Bureau; 2011.
16. Kim J, Peterson KE. Association of infant child care with infant feeding practices and weight gain among US infants. *Archives of Pediatric and Adolescent Medicine*. 2008; 162:627–633.
17. Pearce A, Li L, Abbas J. Is childcare associated with the risk of overweight and obesity in the early years: Findings from the UK Millennium Cohort Study. *International Journal of Obesity*. 2010; 34:1160–1168. [PubMed: 20142828]
18. Benjamin SE, Rifas-Shiman SL, Taveras EM, et al. Early child care and adiposity at ages 1 and 3 years. *Pediatrics*. 2009; 124:555–562. [PubMed: 19651579]
19. Barlow J, Whitlock S, Hanson S, et al. Preventing obesity at weaning: parental views about the EMPOWER programme. *Child Care, Health and Development*. 2010; 36:843–849.
20. Wen L, Baur L, Rissel C. Early intervention of multiple home visits to prevent childhood obesity in a disadvantaged population: a home-based randomized controlled trial (Healthy Beginnings Trial). *BMC Public Health*. 2007; 7:76. [PubMed: 17490492]
21. Wen LM, Baur LA, Simpson JM, et al. Effectiveness of home based early intervention on children's BMI at age 2: randomised controlled trial. *British Medical Journal*. 2012; 344:e3732. [PubMed: 22735103]
22. Wen LM, Baur LA, Simpson JM, et al. Effectiveness of an early intervention on infant feeding practices and "tummy time": A randomized controlled trial. *Archives of Pediatrics & Adolescent Medicine*. 2011; 165:701–707. [PubMed: 21810633]
23. Daniels LA, Mallan KM, Battistutta D, et al. Evaluation of an intervention to promote protective infant feeding practices to prevent childhood obesity: outcomes of the NOURISH RCT at 14 months of age and 6 months post the first of two intervention modules. *International Journal of Obesity*. 2012; 36:1292–1298. [PubMed: 22710926]
24. Horodyski MA, Hoerr S, Coleman G. Nutrition education aimed at toddlers: a pilot program for rural, low-income families. *Family & Community Health*. 2004; 27:103–113. [PubMed: 15596977]
25. de Silva-Sanigorski AM, Bell AC, Kremer P, et al. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. *American Journal of Clinical Nutrition*. 2010; 91:831–840. [PubMed: 20147472]
26. Kavanagh KF, Cohen RJ, Heinig MJ, et al. Educational Intervention to Modify Bottle-feeding Behaviors among Formula-feeding Mothers in the WIC Program: Impact on Infant Formula Intake and Weight Gain. *Journal of Nutrition Education and Behavior*. 2008; 40:244–250. [PubMed: 18565465]
27. Kramer MS, Matush L, Vanilovich I, et al. A Randomized Breast-feeding Promotion Intervention Did Not Reduce Child Obesity in Belarus. *Journal of Nutrition*. 2011; 139:417S–421. [PubMed: 19106322]
28. Taveras EM, Blackburn K, Gillman MW, et al. First steps for mommy and me: a pilot intervention to improve nutrition and physical activity behaviors of postpartum mothers and their infants. *Maternal and Child Health Journal*. 2011; 15:1217–1227. [PubMed: 20957514]
29. Mustila T, Raitanen J, Keskinen P, et al. Lifestyle counselling targeting infant's mother during the child's first year and offspring weight development until 4 years of age: a follow-up study of a cluster RCT. *British Medical Journal*. 2012; 2(1):e000624.

30. Schulz KF, Altman DG, Moher D. CONSORT 2010 Statement: Updated Guidelines for Reporting Parallel Group Randomized Trials. *Annals of Internal Medicine*. 2010; 152:726–732. [PubMed: 20335313]
31. Ammerman AS, Ward DS, Benjamin SE, et al. An Intervention to Promote Healthy Weight: Nutrition and Physical Activity Self-Assessment for Child Care (NAP SACC) Theory and Design. *Preventing Chronic Disease*. 2007; 4:A67. [PubMed: 17572971]
32. Benjamin SE, Ammerman A, Sommers J, et al. Nutrition and physical activity self-assessment for child care (NAP SACC): results from a pilot intervention. *Journal of Nutrition Education and Behavior*. 2007; 39:142–149. [PubMed: 17493564]
33. Ward DS, Benjamin SE, Ammerman AS, et al. Nutrition and physical activity in child care: results from an environmental intervention. *American Journal of Preventive Medicine*. 2008; 35:352–356. [PubMed: 18701236]
34. Ball, S.; Benjamin, S.; Walker, E., et al. The infant and toddler Nutrition and Physical Activity Self-Assessment for Child Care environmental assessment instrument. Nemours Foundation and University of North Carolina at Chapel Hill; 2006. The infant and toddler Nutrition and Physical Activity Self-Assessment for Child Care environmental assessment instrument.
35. Skinner JD, Ziegler P, Pac S, et al. Meal and snack patterns of infants and toddlers. *Journal of the American Dietetic Association*. 2004; 104:s65–70. [PubMed: 14702020]
36. Mulligan L, Specker B, Buckley D, et al. Physical and environmental factors affecting motor development, activity level, and body composition of infants in child care centers. *Pediatric Physical Therapy*. 1998; 10:156–161.
37. Brekke HK, van Odiijk J, Ludvigsson J. Predictors and dietary consequences of frequent intake of high-sugar, low-nutrient foods in 1-year-old children participating in the ABIS study. *British Journal of Nutrition*. 2007; 97:176–181. [PubMed: 17217574]
38. American Academy of Pediatrics, American Public Health Association, National Resource Center for Health and Safety in Child Care. *Caring for Our Children: National Health and Safety Performance Standards*. 2. Washington, DC: 2002.
39. National Association for Sport and Physical Education. *Active Start: a statement of physical activity guidelines for children birth to five years*. 2. NASPE Publications; Reston, VA: 2009.
40. Fox MK, Pac S, Devaney B, et al. Feeding infants and toddlers study: What foods are infants and toddlers eating? *Journal of the American Dietetic Association*. 2004; 104(1 Suppl 1):s22–30. [PubMed: 14702014]
41. Rifas-Shiman SL, Oken E, Taveras EM, et al. Timing of introduction of solid foods and overweight at age 3 years. *Obesity*. 2007; 127(3):e544–51.
42. Briefel RR, Reidy K, Karwe V, et al. Feeding infants and toddlers study: Improvements needed in meeting infant feeding recommendations. *Journal of the American Dietetic Association*. 2004; 104(1 Suppl 1):s31–37. [PubMed: 14702015]
43. Gartner LM, Morton J, Lawrence RA, et al. Breastfeeding and the use of human milk. *Pediatrics*. 2005; 115:496–506. [PubMed: 15687461]
44. Vandewater EA, Rideout VJ, Wartella EA, et al. Digital Childhood: Electronic Media and Technology Use Among Infants, Toddlers, and Preschoolers. *Pediatrics*. 2007; 119:e1006–1015. [PubMed: 17473074]
45. Ward D, Hales D, Haverly K, et al. An instrument to assess the obesogenic environment of child care centers. *American Journal of Health Behavior*. 2008; 32:380–386. [PubMed: 18092898]
46. Fitzgibbon ML, Stolley MR, Schiffer L, et al. Two-year follow-up results for Hip-Hop to Health Jr.: a randomized controlled trial for overweight prevention in preschool minority children. *Journal of Pediatrics*. 2005; 146:618–625. [PubMed: 15870664]
47. Fitzgibbon ML, Stolley MR, Schiffer L, et al. Hip-Hop to Health Jr. for Latino preschool children. *Obesity*. 2006; 14:1616–1625. [PubMed: 17030973]
48. de Silva-Sanigorski AM, Bell AC, Kremer P, et al. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. *The American Journal of Clinical Nutrition*. 2010; 91:831–840. [PubMed: 20147472]

49. de Silva-Sanigorski A, Elea D, Bell C, et al. Obesity prevention in the family day care setting: impact of the Romp & Chomp intervention on opportunities for children's physical activity and healthy eating. *Child: Care, Health and Development*. 2011; 37:385–393.
50. Hardy L, King L, Kelly B, et al. Munch and Move: evaluation of a preschool healthy eating and movement skill program. *International Journal of Behavioral Nutrition and Physical Activity*. 2010; 7:80. [PubMed: 21047434]
51. Herman A, Nelson BB, Teutsch C, et al. "Eat Healthy, Stay Active!": A Coordinated Intervention to Improve Nutrition and Physical Activity Among Head Start Parents, Staff, and Children. *American Journal of Health Promotion*. 2012; 27:e27–e36. [PubMed: 22950932]
52. Williams CL, Strobino BA, Bollella M, et al. Cardiovascular risk reduction in preschool children: the "Healthy Start" project. *Journal of the American College of Nutrition*. 2004; 23:117–123. [PubMed: 15047677]
53. Dennison BA, Russo TJ, Burdick PA, et al. An intervention to reduce television viewing by preschool children. *Archives of Pediatric and Adolescent Medicine*. 2004; 158:170–176.
54. Hesketh KD, Campbell K, Salmon J, et al. The Melbourne Infant Feeding, Activity and Nutrition Trial (InFANT) Program follow-up. *Contemporary Clinical Trials*. 2013; 34(1):145–51. [PubMed: 23117076]
55. Harvey-Berino J, Rourke J. Obesity prevention in preschool native-american children: a pilot study using home visiting. *Obesity Research*. 2003; 11:606–611. [PubMed: 12740449]

Table 1

Behavioral targets of the Baby NAP SACC intervention and corresponding domains from the Environment and Policy Assessment and Observation (EPAO)

Intervention Target Area	Intervention Behavioral Target	EPAO Domain
Support for Breastfeeding	Breastfed infants not fed solid foods before six months without parental permission	Nutrition Staff Behaviors
	Designated place available at center for mothers to breastfeed	Nutrition Environment
	Center has policy supporting breastfeeding	Nutrition Policies
Feeding Infants	Infants fed on demand in response to hunger cues	Nutrition Staff Behaviors
	Solid foods not added to bottle	Nutrition Staff Behaviors
	Bottles not propped/satiety cues respected	Nutrition Staff Behaviors
	Written feeding plan provided by parents and followed by providers	Nutrition Staff Behaviors
	Parents given infant feeding report daily	Nutrition Staff Behaviors
	Juice (100%) not provided	Beverages
	Sugar-sweetened beverages not provided	Beverages
	High sugar and high salt foods limited	High Sugar/Salt/Fat Food
	Variety of fruits and vegetables provided daily	Fruits and Vegetables
	Fried foods not provided	High Sugar, Salt, Fat Food
Feeding Toddlers	Meals and snacks served on a schedule, but flexible for individual child needs/hunger and satiety cues are respected	Nutrition Environment
	Juice (100%) limited	Beverages
	Sugar-sweetened beverages not provided	Beverages
	High sugar and high salt foods limited	High Sugar/Salt/Fat Food
	Variety of fruits and vegetables provided daily	Fruits and Vegetables
	Fried foods not provided	High Sugar, Salt, Fat Food
	High fat meats limited	High Sugar, Salt, Fat Food
	Whole grains provided daily	Grains
	Providers make positive comments about healthy eating	Nutrition Staff Behaviors
Nutrition Education	Providers receive nutrition training yearly	Nutrition Education
	Providers engage in nutrition education with children (formal)	Nutrition Education
	Providers talk with children about healthy eating (informal)	Nutrition Education
Activity for Infants	Infants given time to move freely (unrestricted) daily	Active Time
	Tummy time provided to infants daily	Active Time
	Infants provided outdoor time (unrestricted) for activity daily	Active Time
	Infants not restricted 15 minutes except when sleeping or eating	Sedentary Time
	Infants do not watch television or videos	Sedentary Environment
Activity for Toddlers	Providers encourage toddlers to be active	Physical Activity Staff Behaviors
	Providers make positive comments about activity/movement	Physical Activity Staff Behaviors
	Toddlers provided 20 minutes of active time for every hour in care	Active Time
	Toddlers not restricted 30 minutes except when sleeping or eating	Sedentary Time

Intervention Target Area	Intervention Behavioral Target	EPAO Domain
Physical Activity Education	Toddlers do not watch television or videos >1 hour per week	Sedentary Environment
	Toddlers provided outdoor time for activity daily	Physical Activity Staff Behaviors
	Providers receive physical activity training yearly	Physical Activity Education
	Providers engage in physical activity education with children (formal)	Physical Activity Education
	Providers talk with children about physical activity (informal)	Physical Activity Education
Center Environment	Some meals or snacks served family style (allow children to select portions)	Nutrition Environment
	Providers sit and eat with children	Nutrition Environment
	Climbing play structures varied and accommodate all children	Play Equipment
	Portable play equipment varied and accommodate all children	Play Equipment
	Indoor play space available	Physical Activity Environment
	Centers have written nutrition policy	Nutrition Policies
	Centers have written physical activity policy	Physical Activity Policies

Table 2

Baseline characteristics of the 32 child care centers participating in the Baby NAP SACC intervention by study group

Characteristic	Intervention (n=16)	Control (n=16)	p Value
	<i>Mean (SD)</i>		
Center years in operation	14.7 (7.7)	11.2 (8.4)	0.37
Number of children enrolled	98.2 (144.8)	59.2 (34.4)	0.68
Number of subsidized children enrolled	38.4 (84.9)	20.2 (28.2)	0.91
Number of infants enrolled	6.6 (5.0)	6.4 (4.8)	0.83
Number of toddlers enrolled	10.1 (7.1)	8.1 (5.7)	0.52
Number of staff members in center	24.9 (27.4)	15.5 (7.8)	0.60
Percent children white race	47.5 (37.4)	46.2 (30.3)	0.26
	<i>n (%)</i>		
Participate in the Child and Adult Care Food Program	13 (81%)	10 (63%)	0.38
Center director race, white	13 (81%)	12 (75%)	0.49
Center director education, college graduate	11 (69%)	12 (75%)	0.44
Outdoor play area present at center	12 (75%)	16 (100%)	0.10
Indoor play area present at center	11 (67%)	4 (25%)	0.02

Table 3

Change in Environment and Policy Assessment and Observation (EPAO) score from baseline to six-month follow-up by study group

		Mean (SE)		β (95% CI)			
Outcome		Baseline	Follow-up	Change	Crude Difference	Adjusted Difference ^a	p Value ^b
EPAO Total Score and Sub-Scores							
Total Score							
Intervention		134.5 (7.0)	147.3 (7.9)	12.8 (9.1)	17.0 (-3.86, 37.85)	18.5 (0.13, 36.94)	0.049
Control		146.8 (4.8)	142.6 (7.3)	-4.2 (5.3)			
Nutrition Sub-Score							
Intervention		54.4 (4.5)	66.2 (5.7)	11.8 (7.2)	12.0 (-3.41, 27.49)	6.4 (-7.12, 19.83)	0.385
Control		63.9 (3.1)	63.6 (3.6)	-0.3 (3.2)			
Physical Activity Sub-Score							
Intervention		80.1 (4.3)	81.2 (4.0)	1.1 (4.5)	5.0 (-7.52, 17.44)	12.2 (-1.64, 26.01)	0.075
Control		82.9 (2.5)	79.0 (4.5)	-3.9 (4.0)			

^a Adjusted for child race, number of subsidized children in care, and presence of an indoor play area.

^b p value is for adjusted difference.

Table 4

Change in Environment and Policy Assessment and Observation (EPAO) domain score from baseline to six-month follow-up for interveners compared to non-interveners

EPAO Domains	Number of centers ^a	Mean (95% CI)	p Value ^b
Nutrition Domains			
Fruits and Vegetables			0.23
Interveners	4	4.5 (-1.1, 10.1)	
Non-interveners	22	0.8 (-1.6, 3.2)	
Difference		3.7 (-2.4, 9.8)	
Grains			0.27
Interveners	2	3.3 (-4.6, 11.2)	
Non-interveners	24	-1.2 (-3.5, 1.0)	
Difference		4.6 (-3.7, 12.8)	
High Sugar, Salt, Fat Foods			0.0003
Interveners	3	20.0 (8.8, 31.2)	
Non-interveners	23	-1.0 (-3.2, 1.3)	
Difference		21.0 (9.5, 32.4)	
Beverages			0.18
Interveners	6	4.3 (-0.2, 8.9)	
Non-interveners	20	0.8 (-1.7, 3.3)	
Difference		3.6 (-1.6, 8.8)	
Nutrition Environment			0.09
Interveners	7	4.6 (0.4, 8.8)	
Non-interveners	19	0.4 (-2.2, 2.9)	
Difference		4.3 (-0.7, 9.2)	
Nutrition Staff Behaviors			0.005
Interveners	6	8.3 (1.9, 14.8)	
Non-interveners	20	-1.5 (-3.8, 0.9)	
Difference		9.8 (2.9, 16.7)	
Nutrition Education			0.16
Interveners	4	10.0 (-1.2, 21.2)	
Non-interveners	22	1.8 (-0.4, 4.0)	
Difference		8.2 (-3.2, 19.6)	
Nutrition Policies		Not estimable	--
Interveners	0		
Non-interveners	26		
Difference			

EPAO Domains	Number of centers ^a	Mean (95% CI)	p Value ^b
Physical Activity Domains			
Active Time			0.24
Interveners	7	4.6 (-1.0, 10.2)	
Non-interveners	19	0.9 (-1.5, 3.3)	
Difference		3.7 (-2.4, 9.8)	
Sedentary Time			0.02
Interveners	4	6.7 (0.2, 13.1)	
Non-interveners	22	-1.6 (-3.9, 0.7)	
Difference		8.3 (1.4, 15.1)	
Sedentary Environment			0.41
Interveners	6	1.7 (-3.9, 7.3)	
Non-interveners	20	-0.9 (-3.3, 1.5)	
Difference		2.6 (-3.5, 8.7)	
Physical Activity Environment			0.02
Interveners	3	5.7 (-2.2, 13.6)	
Non-interveners	23	-4.2 (-6.5, -1.9)	
Difference		9.9 (1.7, 18.1)	
Play Equipment			0.24
Interveners	4	3.8 (-1.2, 8.8)	
Non-interveners	22	0.5 (-2.0, 2.9)	
Difference		3.3 (-2.2, 8.9)	
Physical Activity Staff Behaviors			0.02
Interveners	6	6.4 (1.4, 11.4)	
Non-interveners	20	-0.1 (-2.6, 2.3)	
Difference		16.5 (1.0, 12.1)	
Physical Activity Education			0.89
Interveners	2	0.0 (-11.2, 11.2)	
Non-interveners	24	-0.8 (-3.0, 1.4)	
Difference		0.8 (-10.6, 12.2)	
Physical Activity Policies		Not estimable	--
Interveners	0		
Non-interveners	26		
Difference			
Overall F test		3.6	<0.0001

^a Each intervention center director selected two nutrition and two physical activity areas for improvement during the course of the intervention. "Interveners" includes those intervention centers that selected the EPAO domain for intervention. "Non-interveners" includes both control centers and intervention centers that did not select the domain for intervention.

^b Adjusted for child race, number of subsidized children in care, and presence of an indoor play area.