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Guest Editors: Li Ming Wen, Chris Rissel, and Gengsheng He

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Editorial Board

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Editorial

The Effect of Early Life Factors and Early Interventions on Childhood Overweight and Obesity 2016

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Increasing prevalence of infant and childhood obesity around the world is a major public health concern [1]. If current trends continue, the number of overweight or obese infants and young children globally will increase to 70 million by 2025 [2]. Without the implementation of secondary prevention or early intervention programs, obese infants and young children will likely continue to be obese during childhood, adolescence, and adulthood. Determining the early life factors associated with obesity is key to developing early intervention strategies and preventing obesity among young children in the first few years of life. Thus, there is an urgent need for a better understanding of the effect of early life factors on overweight and obesity and, more importantly, for the development of effective early interventions.

Over recent years there have been an increasing number of research studies on early life factors and their effects on the childhood obesity. Research into the effects of early interventions on childhood overweight and obesity has also been gathering momentum [3, 4]. In 2015, we edited the first special issue on "The Effect of Early Life Factors and Early Interventions on Childhood Overweight and Obesity" [5] (https://www.hindawi.com/journals/jobe/2015/964540/), which included a number of interesting and important studies. It has become apparent that early infant feeding practices, children's eating habits, and television viewing time are among the most identifiable factors contributing to the early onset of childhood obesity. Providing parents with evidence-based advice and recommendations can improve parental knowledge and practice regarding obesity prevention. However, much more needs to be done to better understand the major contributing factors to obesity in the early years and what interventions can be effective for preventing childhood obesity. With this in mind we selected this theme again for this second special issue.

There was a good response to the call for this special issue, with various research ideas and pilot intervention studies on obesity prevention in the early years. We highly commend the authors for their well written papers exploring a range of issues related to early life factors associated with childhood obesity, which include epidemiological investigations, research reviews, and intervention studies at early life-stages with various populations. In this editorial we wish to highlight some interesting lessons from these studies.

Hughes et al. investigated the influence of feeding styles and food parenting practices on low-income children's weight status over time with 129 Latina parents and their children participating in a longitudinal study. Children were assessed at baseline (4 to 5 years old) and again eighteen months later. At each time point, parents completed questionnaires and height and weight measures were taken on the child. Their results showed that the indulgent feeding style (parent report at baseline) was associated with increased child BMI score eighteen months later compared to other feeding styles. Authoritative, authoritarian, and uninvolved feeding styles were not significantly associated with increased child BMI score. The study was the first to investigate the impact of feeding styles on child weight status over time and highlights the importance of feeding style in childhood obesity prevention and the role of indulgent feeding in predicting later increases in children's weight status. We believe that the interplay between feeding styles and feeding practices in influencing child weight status needs to be further explored.

No or short duration of breastfeeding is also related to feeding practices and has been identified as an important risk factor for childhood obesity [6]. Adams et al. examined breastfeeding practices among Native Hawaiians and Pacific Islanders (NHPI) women through searching seven databases and reference lists based on predetermined criteria and conducted a meta-analysis. They found only nine studies met the inclusion criteria and most studies were cross-sectional with no randomized or quasi-randomized control trials being conducted. Their results indicated that 47% NHPI women initiated breastfeeding with 41% breastfeeding exclusively which were below the recommended national and international goals and guidelines. The study highlighted breastfeeding practices among NHPI women are heterogeneous and critical disparities exist among certain NHPI subgroups and additional research needs to be conducted to determine the reasons for the disparity. Future studies should be conducted to explore barriers and enablers of breastfeeding among the various subpopulations of NHPI women. We believe that the study findings can be applied to other populations, and multicomponent, multilevel strategies are needed to support breastfeeding practices.

Recognising the role of childcare settings in improving obesity-related behaviours, Vinci et al. conducted a feasibility and acceptability study of training teachers to incorporate student intervention curriculum materials in classroom-based activities in order to promote physical activity (PA) in childcare classrooms. They conducted an evidence scan, key informant, and focus group interviews with childcare directors and staff and environmental self-assessment of childcare facilities to inform the design of the training curriculum. Feedback from the interviews indicated that childcare providers believed in the importance of teaching children about PA and were supportive of training teachers to incorporate PA into classroom settings. The Promoting PA in Childcare Setting Curriculum was developed. and training was implemented with 16 teachers. Participants reported a positive experience with the hands-on training and reported acquiring new knowledge that they intended to implement in their childcare settings. Their findings highlight the feasibility of working with childcare staff to develop PA training and curriculum. We believe that there is a great potential for childcare staff to incorporate intervention curriculum materials in classroom-based activities in order to promote physical activity in childcare classrooms.

Acknowledging that parents play a critical role in obesity prevention [7], Foster et al. assessed the feasibility of a parent mentor model of intervention for early childhood obesity using positive deviance-based methods to inform the intervention. In their pilot study parent-child dyads (children aged: 2–5 years) with children whose body mass index (BMI) was ≥95th percentile were randomized to parent mentor intervention or community health worker comparison. The child's height and weight were measured at baseline, after the six-month intervention, and six months after the intervention. Their results showed that, at the end of the intervention, the BMI z-score for the parent mentor group was 2.48 (SD = 0.58) and for the community health worker group it was 2.45 (SD = 0.91), both reduced from baseline. We believe that a parent or community health worker mentor program is feasible and both achieved sustained effects on adiposity in an obese child. But further well designed studies with a larger sample size are needed.

Interventions targeting parents and focused on modifiable factors to prevent obesity and promote healthy growth in the first 1000 days of life have received attention in recent years. Utilizing nutrition education theories, Uesugi et al. described the design of a digital-based nutrition guidance system targeted to first-time mothers to prevent obesity during the first two years. The multicomponent system consists of scientifically substantiated content, tools, and telephone-based professional support delivered in an anticipatory and sequential manner via the internet, email, and text messages, focusing on educational modules addressing the modifiable factors associated with childhood obesity. Digital delivery formats leverage consumer media trends and provides the opportunity for scale-up, unavailable to previous interventions reliant on resource heavy clinic and home-based counselling. Designed initially for use in the United States, this system's core features are applicable to all contexts and constitute an approach fostering healthy growth, not just obesity prevention. The multicomponent features, combined with a global concern for optimal growth and positive trends in mobile internet use, represent this system's future potential to affect change in nutrition practice in developing countries. We believe that scale-up of interventions to global populations is necessary to reverse trends in weight status among infants and toddlers, and large scale dissemination will require understanding of effective strategies.

In conclusion, the early onset of childhood overweight and obesity requires the implementation of secondary prevention or early intervention programs to commence as early as possible. A better understanding of the early life factors associated with childhood obesity can help inform the development of appropriate intervention programs. We recommend the original papers in this second special issue addressing "The Effect of Early Life Factors and Early Interventions on Childhood Overweight and Obesity." We also recognize that much more research is needed to address this substantial public health problem.

Li Ming Wen
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Research Article

Establishing Waist-to-Height Ratio Standards from Criterion-Referenced BMI Using ROC Curves in Low-Income Children

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The purpose of this study was to establish health-related waist-to-height ratio (WHtR) cut-points associating with FITNESSGRAM's body mass index (BMI) criterion-referenced standards in low-income children. A secondary aim was to examine the classification agreement between the derived WHtR cut-points and various cardiometabolic blood markers using current recommendations. Participants were 219 children from low-income schools (mean age = 10.5 ± 0.6 years). Waist circumference, height, weight, and cardiometabolic blood markers were collected in a fasting state before school hours. Receiver operating characteristic (ROC) curves were used to determine WHtR cut-points that associated with a child meeting FITNESSGRAM's age- and sex-specific criterion-referenced standards for BMI. The derived WHtR cut-point was 0.50 (AUC = 0.89, $p < 0.001$; sensitivity = 0.86, specificity = 0.82, and accuracy = 84.3%). Classification agreement using the derived WHtR cut-point with various blood marker standards was statistically significant but considered weak to fair (kappa 0.14–0.34, agreement = 59%–67%, and $p < 0.01$). The WHtR cut-point of 0.50 can be used with strong accuracy to distinguish low-income children who met FITNESSGRAM's criterion-referenced standards for body composition; however, the evidence was weaker for its use in distinguishing low-income children meeting specific cardiometabolic blood marker recommendations.

1. Introduction

Optimizing health-related fitness (HRF) is an effective strategy for attenuating cardiometabolic disease health risk in the pediatric population [1, 2]. HRF consists of five components including body composition, cardiorespiratory endurance, muscular strength and endurance, and flexibility [3]. Of these five components, body composition and cardiorespiratory endurance have the strongest links to health outcomes in children and adolescents [4, 5]. Therefore, optimizing body composition and cardiorespiratory endurance may decrease the incidence of cardiometabolic disease risk factors [6]. This may especially be important in low-income children where the prevalence of obesity and unfavorable obesity-related cardiometabolic disease risk factors is significantly greater compared to higher socioeconomic status pediatric populations [7, 8].

Currently in the USA, HRF is assessed using the FITNESSGRAM, the national fitness test battery (http://www.fitnessgram.net). For body composition, FITNESSGRAM recommends the use of percent of body fat or body mass index (BMI) [9–11]. Because of the logistic limitations of acquiring estimated percent of body fat from sum of skinfolds assessment in physical education settings, BMI is often used because of its ease of administration and calculation. The BMI standards are currently age- and sex-specific when employing the FITNESSGRAM [3]. Instead of providing a child with an absolute BMI score, children are classified into Healthy Fitness Zones, which gives the child personalized messages based on their current estimated body composition [12].

The two primary Healthy Fitness Zones include the Healthy Fitness Zone (HFZ), a zone where a child is given a message stating that he or she is at a level of good health, and the Needs Improvement (NI), a zone that gives the message that a child should strive to improve their BMI to attenuate health risk. The current version of FITNESSGRAM (v.10) states that the cut-points for BMI are adjusted to align with the age- and sex-specific Centers for Disease Control and Prevention BMI percentiles, using the 83rd and 92nd percentiles for boys and the 80th and 90th percentiles for girls. These cut-points have been validated using a metabolic syndrome criterion in a large sample of adolescents aged 12–19 years from the National Health and Nutrition Examination Survey [13].

Despite the benefits of BMI in field settings, specifically in physical education, the index contains inherent limitations. The original development for BMI was for population surveillance, to monitor body composition within large groups of people [14]. However, it is currently widely used for individual body composition assessment [15]. Its use at the individual level has been under scrutiny because of its inability to distinguish between fat mass and fat-free mass [16]. BMI also does not specify where fat is distributed on a person's body, as visceral adipose deposits have been shown to pose more of a health risk compared to subcutaneous deposits [17].

An increasingly popular alternative to BMI is waist-to-height ratio (WHtR) [18]. WHtR is simply an individual waist circumference divided by their height. Some studies have shown that this index is better at distinguishing children and adolescents with unfavorable cardiometabolic risk factors than BMI [19]. However, the discordance in BMI and WHtR estimations of individual body composition may be more evident after the commencement of puberty in both girls and boys, when hormonal changes elicit different fat and fat-free mass distributions and deposit rates on the body [20]. Despite this, the use of WHtR in younger children still may have utility, especially to monitor central adiposity. Indeed, in the low-income pediatric population, central (or visceral) adiposity has been shown to be more prevalent compared to children of a higher socioeconomic status [20, 21].

No study to date has developed WHtR cut-points associating current FITNESSGRAM standards for body composition. Also, examining the agreement of the derived WHtR cut-point with cardiometabolic blood marker recommendations will give evidence for the strength of its utility in clinical settings for identifying low-income children at risk for early onset cardiometabolic disease. Therefore, the purpose of this study was to derive a WHtR cut-point associating with meeting FITNESSGRAM's age- and sex-specific criterion-referenced standards for BMI in low-income children from the USA. A secondary aim was to examine the classification agreement between children meeting the derived WHtR cut-point with meeting standards for various cardiometabolic blood markers using recommendations from the National, Heart, Lung, and Blood Institute.

2. Material and Methods

2.1. Participants. Participants were a nonprobability convenience sample of 219 children from five low-income schools from the Mountain West region of the US (mean age = 10.5 ± 0.6 years; 126 girls and 93 boys). Children were recruited from the fourth through the sixth grades and were primarily of a Hispanic ethnic background (210/219, 95.8%). Approximately 91%–96% of the children at each school were from low-income families. Written assent was obtained from each child and written consent was obtained from each child's parent or guardian prior to data collection. There were no exclusion criteria given for recruitment of the children and all children were in good physical condition for physical assessment. The University Institutional Review Board approved the protocols employed in this study.

2.2. Measures

2.2.1. Body Mass Index and Waist-to-Height Ratio. Height was measured to the nearest 0.5 centimeter using a portable stadiometer (SECA 213; Hanover, MD, USA). With shoes off, weight was measured to the nearest 0.1 kg using a portable medical scale (BD-590; Tokyo, Japan). BMI was calculated taking each child's weight (in kg) divided by square of height (in meters). Waist circumference was measured in a private screening area where three abdominal circumference measurements were taken at the level of the superior border of the iliac crest on the participant's right side using a standard measuring tape. All measurements were estimated to the nearest 0.5-centimeter with the average of the three measurements used for data analysis. WHtR was calculated taking the child's waist circumference in centimeters divided by their height in centimeters. The anthropometric measures (i.e., BMI and waist circumference) were collected by a trained graduate research assistant to maintain testing consistency and were collected in accordance with the American College of Sports Medicine guidelines.

2.2.2. Cardiometabolic Blood Markers. Each child's cardiometabolic biomarkers were collected using the Cholestech LDX system (Alere Inc., Waltham, MA, USA). Individual blood markers included total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides, and blood glucose. A capillary blood sample was collected between the hours of 6 am and 8 am before the start of the school day. All blood samples were collected in a fasting state, verbally verified by both the child and the child's parent or guardian. Blood samples were collected using a finger stick on each child's right index finger using a 40 μL capillary tube and injected into a Lipid Profile-Glucose Cassette (Alere Inc., Waltham, MA, USA) to be subsequently analyzed. The puncture site was cleaned and bandaged and all materials were properly disposed of in a biohazard container.

Blood pressure was measured using an electronic blood pressure device (CONTEC08A, Contec Medical Systems Co., Qinhuangdao, China). Systolic blood pressure and diastolic blood pressure measurements were taken on each child's right arm with the right arm rested and elevated at heart level and both feet flat on the ground. Blood pressure measurements were collected while the children were seated, immediately following a seated five-minute relaxation period.

2.3. Procedures. Anthropometric measurements (i.e., BMI and WHtR), blood markers, and blood pressure measurements were collected on the same testing day. Anthropometric measurements were collected first, blood markers collected second, and blood pressure measurements collected third for all students. Students not reporting to the data collection site in a fasting state were rescheduled.

2.4. Data Processing. Each child's BMI was stratified into FITNESSGRAM's HFZ or NI [22]. Only two of the three FITNESSGRAM fitness zones were used for classification in order to create a binary predictor variable for BMI. The cardiometabolic blood marker continuous variable scores were also stratified into a binary classification scheme based on US National Heart, Lung, and Blood Institute recommendations [23]. Unfavorable cardiometabolic measurements were defined as having total cholesterol ≥ 170 mg/dL, LDL cholesterol ≥ 110 mg/dL, HDL cholesterol ≤ 45 mg/dL, triglycerides ≥ 90 mg/dL, blood glucose ≥ 100 mg/dL, and systolic and diastolic blood pressure measurements ≥ 95th percentile as determined by age and sex. The aforementioned binary variables were coded as 0 = not meeting recommendations and 1 = meeting recommendations for WHtR and blood markers and 0 = NI and 1 = HFZ for BMI.

2.5. Statistical Analysis. For descriptive purposes, differences between sex groups on all continuous measures were examined using independent t-tests. The primary analysis involved using a Receiver Operating Characteristic (ROC) curve to determine the optimal WHtR cut-point needed to accurately discriminate children who did and who did not achieve FITNESSGRAM's age- and sex-specific recommendations for BMI. Overall diagnostic power was determined using the area-under-the-curve (AUC). AUC scores of ≥0.90 were considered excellent; 0.80–0.89, good; 0.70–0.79, fair; and <0.70, poor [21]. The optimal WHtR cut-point was determined using maximum Youden's J statistic ($J_{\max}$), which was calculated using STATA's "senspec" command. Youden's J is the point on the ROC curve that maximizes the sum of sensitivity and specificity ($J_{\max} = \max((\text{sensitivity} + \text{specificity}) - 1)$). Sensitivity was the probability that a child achieved a WHtR cut-point (T^+) given that he or she met the FITNESSGRAM standard for BMI (D^+), or P ($T^+ \mid D^+$). Sensitivity is synonymous with the probability of achieving a true positive. Specificity was the probability that a child did not meet a WHtR cut-point (T^-) given that he or she did not meet the FITNESSGRAM standard for BMI, P ($T^- \mid D^-$), or a true negative [24]. Maximizing sensitivity and specificity associates with the datum closest to $(0, 1)$ on the ROC curve and is a WHtR cut-point that is likely to yield strong classification accuracy.

Classification agreement between children meeting the WHtR cut-point and children meeting each cardiometabolic blood marker standard was examined using kappa statistics and percentage of agreement. The kappa statistics were interpreted as weak if <0.20, fair if 0.20–0.39, moderate if 0.40–0.59, good if 0.60–0.79, and very good if ≥0.80 [25]. Alpha level was set at $p \leq 0.05$ and all analyses were carried out using STATA v14.0 statistical software package (College Station, TX, USA).

3. Results

The descriptive statistics for all continuous variables are presented in Table 1 for the total sample and within sex groups. Comparing sex groups, girls displayed higher triglycerides than boys (mean difference = 12.4 mg/dL, $p < 0.01$) and boys displayed higher diastolic blood pressure than girls (mean difference = 3.6 mmHg, $p < 0.01$). There were no other statistically significant differences between sexes for any other measure. Table 2 presents the distribution of children meeting cardiometabolic blood marker recommendations from the National Heart, Lung, and Blood Institute. The range for meeting the various recommendations was 51.5% for triglycerides to 91.7% for blood glucose.

Figure 1 is the ROC curve showing the range of sensitivity and 1 − specificity for various WHtR cut-points associating with a child meeting FITNESSGRAM's age- and sex-specific criterion-referenced standards for BMI. Results from the ROC curve analysis yielded an optimal WHtR cut-point of 0.50 ($J_{\max} = 0.68$, AUC = 0.89, and $p < 0.001$; sensitivity = 0.86, specificity = 0.82, and accuracy = 84.3%). The AUC was considered good. Using the derived cut-point, approximately 55% of the sample displayed a WHtR ≤ 0.50 (120/219). Table 3 presents the agreement statistics between children meeting the derived WHtR cut-point with children meeting the recommendations for each cardiometabolic blood marker. All kappa statistics were statistically significant except for LDL cholesterol. Statistically significant kappa statistics were considered weak to fair and ranged from kappa = 0.14 for total cholesterol to kappa = 0.34 for systolic blood pressure. The percentage agreement thus ranged from 58.6% for total cholesterol to 66.8% for systolic blood pressure.

4. Discussion

The purpose of this study was to establish a WHtR cut-point that associated with FITNESSGRAM's age- and sex-specific criterion-reference standards for BMI. A secondary aim was to use the cut-point to analyze classification agreement with various cardiometabolic blood markers using recommendations from the National Heart, Lung, and Blood Institute. The primary finding from this study was that the derived WHtR cut-point of 0.50 strongly agreed with BMI criterion-referenced standards used in the FITNESSGRAM battery. Approximately 84% of children were correctly classified using the 0.50 cut-point and only 16% of children were misclassified. The 0.50 WHtR cut-point has been recommended in other works within the child and adolescent populations [24, 26, 27].

The simple recommendation of keeping a waist circumference less than one-half of height holds merit in the low-income pediatric population as well when distinguishing children who achieved FITNESSGRAM's body composition standards. In other work, this cut-point has been shown to relate moderately well to cardiometabolic risk factors in

Table 1: Descriptive data for the total sample and within sex groups (means and standard deviations).

	Total sample (N = 219)	Girls (n = 126)	Boys (n = 93)
BMI[a] (kg/m^2)	19.1 (4.3)	18.9 (4.6)	19.3 (3.8)
WHtR[b]	0.49 (0.08)	0.48 (0.08)	0.50 (0.07)
Total cholesterol (mg/dL)	153.1 (27.7)	153.1 (26.4)	153.2 (29.4)
LDL cholesterol (mg/dL)	87.1 (26.7)	85.3 (24.4)	90.0 (29.9)
HDL cholesterol (mg/dL)	44.6 (13.2)	44.5 (12.1)	44.7 (14.6)
Triglycerides (mg/dL)	112.6 (82.8)	**112.0† (94.1)**	99.6 (62.2)
Glucose (mg/dL)	86.1 (9.6)	86.1 (10.0)	86.1 (9.0)
Systolic blood pressure (mmHg)	112.9 (14.6)	113.0 (14.4)	112.9 (15.0)
Diastolic blood pressure (mmHg)	67.1 (10.9)	65.6 (10.5)	**69.2† (11.2)**

Note. [a]BMI stands for body mass index; [b]WHtR stands for waist-to-height ratio; bold indicates statistical differences compared to the opposite sex, $^\dagger p < 0.01$.

Table 2: Number of children meeting standards/recommendations for each measure (expressed as counts and percentages).

	Meeting	% meeting	Not meeting
BMI	118	53.8%	101
Total cholesterol	172	78.5%	47
LDL cholesterol	193	88.1%	26
HDL cholesterol	98	44.7%	121
Triglycerides	113	51.5%	106
Glucose	201	91.7%	18
Systolic blood pressure	107	48.8%	112
Diastolic blood pressure	138	63.0%	81

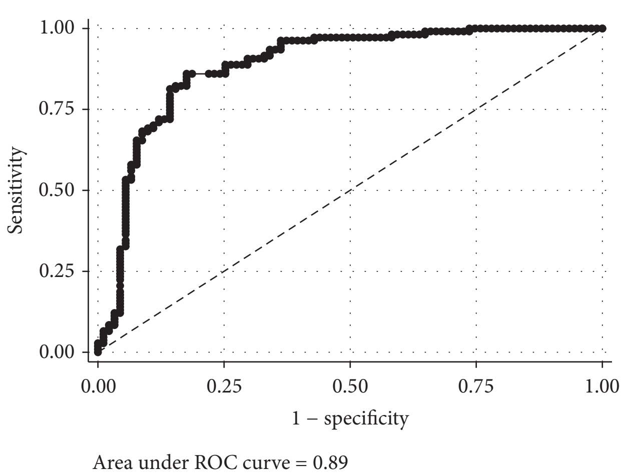

Figure 1: Receiver operating characteristic curve displaying the sensitivity and 1 − specificity scores for waist-to-height ratio cut-points associating with children meeting FITNESSGRAM's body composition criterion-referenced standards.

children, adolescents, and adults [28, 29]. The established WHtR cut-point has the benefit of being developed from FITNESSGRAM's criterion-referenced standards for BMI. FITNESSGRAM's criterion-referenced standards for BMI were developed from percent of body fat estimated from skinfold thickness, which was linked to the metabolic syndrome using a large sample of children and adolescents from the US National Health and Nutrition Examination Survey [11]. The BMI standards are currently used as part of a comprehensive fitness test battery in physical activity or physical education settings. Other researches have found WHtR cut-points ranging between 0.60 in obese Mexican adolescents [30], 0.47 in young Brazilian children [31], 0.465 in female and 0.455 in male South African children [32], and 0.475 in female and 0.485 in male Chinese children [18]. The discordance in developed WHtR cut-points may be the result of the referent variable used for comparison (e.g., metabolic syndrome, percent of body fat, and BMI), genetics, diet, age, sex, and the procedures and instrumentation used to collect anthropometric and health measurements [33]. Despite this, the cut-points derived from various studies approximate the 0.5 cut-point found in this study, which is in exact accordance with the weighted mean boundary found from a recent meta-analysis [33].

In addition to its relative ease of interpretation, WHtR also has the benefit of capturing visceral adipose deposition, which has been shown to increase low-grade systemic inflammation in the body, a possible genesis for early incident cardiometabolic disease risk factors [34]. One limitation of WHtR is that some administered training may be needed to yield a reliable and valid waist circumference measurement, whereas, with BMI, no training is needed. However, WHtR in many studies has been shown to classify individuals of all ages with greater accuracy than BMI because of its ability to isolate central adiposity [35]. Height and bone structure confounding is partially controlled for when dividing the waist measurement by height; therefore its validity as a body composition index is robust regardless of stature.

Although WHtR strongly agreed with BMI standards, its ability to distinguish children who did or did not meet individual cardiometabolic blood markers was classified as weak to fair. Most studies show an association between WHtR and individual and clustered cardiometabolic biomarkers [36]. WHtR has also been found to be associated with certain health behaviors in children such as TV viewing, sedentary behavior, and irregular breakfast [37]. In this study the accuracy in distinguishing children with unfavorable cardiometabolic biomarkers has been found to be similar compared to previous research [31, 32]. The relative lower accuracy of WHtR in children compared to older cohorts may

Table 3: Classification agreement using the derived WHtR cut-point and cardiometabolic blood marker recommendations.

	Kappa (95% CI)	p value	% of agreement
Total cholesterol	**0.14 (0.01, 0.26)**	0.015	58.6%
LDL cholesterol	0.04 (−0.07, 0.16)	0.215	53.1%
HDL cholesterol	**0.33 (0.20, 0.46)**	<0.001	66.5%
Triglycerides	**0.22 (0.08, 0.36)**	0.001	61.5%
Glucose	**0.13 (0.04, 0.21)**	0.002	59.1%
Systolic blood pressure	**0.34 (0.21, 0.48)**	<0.001	66.8%
Diastolic blood pressure	**0.26 (0.13, 0.39)**	<0.001	64.0%

be because of the greater difficulty to detect unfavorable risk factors because these traits may take several years to develop. Indeed, the prevalence for unfavorable biomarkers was less than 50% for most measures, except for HDL cholesterol and diastolic blood pressure, and quite low for total cholesterol, LDL cholesterol, and fasting glucose. Another reason for the weak accuracy in WHtR classifying children may have been because of the use of a capillary blood sample to collect the biomarkers. Capillary blood sampling, although convenient, may overestimate certain biomarkers compared to venous blood sampling [38]. Future research should use venous blood sampling to possibly yield more valid results.

This is the first study to establish a WHtR cut-point associating with FITNESSGRAM's criterion-references standards for BMI in low-income children. This is also the first study to associate WHtR with standards developed from FITNESSGRAM. Practically, the results from this study yield certain implications. WHtR can be used as an alternative to BMI in field settings, specifically in physical education settings for body composition assessment. As stated previously, WHtR has the benefit of capturing central adipose deposits that pose more of a health threat compared to subcutaneous deposits on a child's body [30]. Screening for central adiposity at an early age may help attenuate the risk of developing visceral adipose deposits later in life and thus attenuate incidence of unfavorable cardiometabolic disease risk factors. Although the accuracy of distinguishing low-income children with unfavorable cardiometabolic disease risk was weak to fair, statistically significant agreement was still found; therefore there is still utility for WHtR's use as a cardiometabolic screening tool. However, future research needs to explore these associations further using larger sample sizes, venous blood sampling, and more ethnically diverse samples.

There are limitations to this study that must be considered before generalizations can be made. First, the sample consisted of low-income children, primarily Hispanic, from schools located within the Mountain West region of the USA. Therefore, the external validity of the results is questionable if the results are to be generalized to higher socioeconomic status children or to samples comprising different ethnic representation. Second, a capillary blood sample was obtained to analyze the cardiometabolic blood markers, which may overestimate levels within 5% compared to venous blood samples. Third, the acquired sample size of 219 children is relatively low for cross-sectional descriptive studies employing ROC curves analysis; therefore future research should address the research question using larger sample sizes to improve statistical power and the internal validity of the results. Finally, diet was not accounted for in the analysis, which may influence cardiometabolic health markers. Future research should account for the potential confounding of diet when examining the relationship between WHtR and cardiometabolic health.

5. Conclusion

In conclusion, the derived WHtR cut-point of 0.50 strongly agreed with FITNESSGRAM's criterion-referenced standards for BMI. The WHtR = 0.50 cut-point has also been indicated in prior research within the adolescent and adult populations and may provide a valid alternative to BMI as a body composition assessment metric in low-income children. Despite the strong agreement with BMI, its ability to distinguish low-income children who achieved individual blood marker recommendations was weak to fair. This may have been because of the low prevalence of certain risk factors or the use of capillary blood sampling. This study was the first to establish a WHtR cut-point that associated with criterion-referenced BMI using a sample of low-income children from the USA. The WHtR = 0.50 cut-point can be used with strong accuracy in field settings to distinguish children who would meet standards using FITNESSGRAM's BMI, but its use for screening for a child's cardiometabolic disease risk needs further exploration.

Competing Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Review Article

Breastfeeding Practices among Native Hawaiians and Pacific Islanders

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Background. Breastfeeding is associated with a decreased risk of obesity in the early and adult years. Native Hawaiians and Pacific Islanders (NHPI) experience high rates of obesity which is often obfuscated with aggregated data. Using disaggregated data, we examined breastfeeding practices among NHPI. *Methods*. Seven databases and reference lists were searched. Two independent researchers extracted relevant studies based on predetermined criteria. Nine studies met our inclusion criteria and a meta-analysis was conducted using random-effects, inverse-various weighted models. *Results*. Few studies disaggregated NHPI populations when examining breastfeeding practices. Most studies were cross-sectional and our search yielded no randomized or quasirandomized control trials. The results of the meta-analysis indicated that 46.5% NHPI women initiated breastfeeding with 40.8% breastfeeding exclusively. These pooled analyses show that NHPI breastfeeding practices are below the recommended national and international goals and guidelines. *Conclusion*. Breastfeeding practices among NHPI are heterogeneous and critical disparities exist among certain NHPI subgroups and additional research needs to be conducted to determine the reasons for the disparity. Future studies should work to disaggregate data for NHPI and the various subpopulations. Multicomponent, multilevel strategies are needed to support breastfeeding practices among NHPI.

1. Introduction

Obesity prevention begins with breastfeeding [1] and infancy (0 to 3 years) is a critical period in obesity development [2]. Recent research suggests a 15% to 30% reduction in adolescent and adult obesity rates with breastfeeding during infancy compared with none [1, 3–7]. Breastfeeding's effects are dose dependent, with exclusive breastfeeding (EBF) and breastfeeding for long durations offering increased benefits [4, 8–13], including several short- and long-term medical, neurodevelopmental, and immunological cognitive advantages [14–19]. Due to these benefits, EBF is recommended for a minimum of six months after birth, followed by continued breastfeeding for a minimum of one year [1, 20–23].

Native Hawaiian and Pacific Islanders (NHPI) are a rapidly growing population and constitute approximately 1.2 million of the Asian American population either alone (44%) or in combination with other races (56%) [24]. Because NHPI are often conflated with Asian Americans and other Pacific Islanders in national and state-level data, disparities among them are often unnoticed. For example, when breastfeeding data are disaggregated by race and ethnicity, studies show that NHPI have lower breastfeeding initiation and EBF rates and have shorter breastfeeding duration than other populations [25–27]. This is concerning because NHPI populations experience higher rates of obesity and obesity-related comorbidities and mortality than other populations, but improving breastfeeding practices can ameliorate obesity-related issues [28–34]. Although steps have been taken to separate Asian and NHPI in census data, the problem of aggregating these groups is still prevalent [35].

Currently, there are no systematic reviews on breastfeeding practices that disaggregate data on NHPI. The information from such a systematic review can provide policy makers, researchers, and public health workers a means to support and enhance breastfeeding practices among NHPI while addressing the problem of high obesity. Therefore, the objectives of this study are to provide a systematic review and meta-analysis of breastfeeding practices used by NHPI in terms of initiation, EBF, and duration.

2. Methods

Searches were conducted in July 2013, October 2014, and updated in January 2016 in the online bibliographic databases PubMed, AGRICOLA, CENTRAL, CINAHL, PsychInfo, Sociological Abstracts, and Web of Knowledge for studies examining breastfeeding practices among NHPI. We used Medical Subject Heading (MeSH) terms in PubMed and other indexing terms for the respective databases, as well as text wording. Our initial searches combined the following terms: *breast feeding, breast-feeding, breastfeeding, breastfed, breast fed, breast-fed, child, preschool, infant*, *Pacific Island, Oceanic ancestry group, Hawaii, breastfeed, bottle feeding, formula fed, formula milk, human milk, infant feeding, weaning, child preschool, infant, and pregnancy*. We did not include language or date restrictions in our searches. Two researchers (*IA and AK*) independently scanned the reference lists of all relevant papers retrieved and extracted relevant studies using predetermined inclusion and exclusion criteria. Discrepancies were resolved through discussion so that consensus could be attained.

2.1. Inclusion. Studies were included if data were disaggregated for NHPI populations and if they were directly related to breastfeeding practices. Excluded articles were those that were conducted outside of the United States or the Pacific Islands (Micronesia, Melanesia, and Polynesia) or qualitative in nature.

2.2. Coding. Two researchers independently coded studies for type, sample size, outcome measures, and effect size. The effect size of interest was the proportion of mothers who adopted certain breastfeeding practices (initiation, exclusive breastfeeding, and duration) or children on whom these practices were used.

2.3. Synthesis. We performed two synthesis techniques: (1) a narrative report of breastfeeding practices among NHPI samples in all studies and (2) a meta-analysis of various breastfeeding practice measures using a random-effects, inverse-various weighted model, with effect sizes grouped according to similar measurement constructs. For example, we synthesized measures of breastfeeding initiation separately from breastfeeding duration and exclusivity. Heterogeneity among the effect sizes was calculated using I^2 index [43]. All analyses were conducted using R package *metafor* [44].

3. Systematic Review

We identified 718 articles from which we removed 336 duplicates; and, of 382 articles screened for potential relevance, 348 were excluded. Thirty-four articles were assessed for eligibility. Further studies were excluded because they (1) were outside of the United States or Pacific Islands ($N = 8$), (2) addressed complementary feeding or did not disaggregate NHPI from other ethnic groups ($N = 16$), (3) described interventions (without reporting effects) ($N = 1$), and were secondary data from other included studies. Hence, nine studies were included in our final results. See Figure 1.

4. Main Findings of the Selected Studies

Study dates ranged from 1969 to 2013. Six studies were conducted before the year 2000. Studies were cross-sectional [26, 27, 36, 37, 39, 41] and each one was cohort [38], panel [40], and univariate descriptive [42]. Furthermore, just over half of the studies were conducted in Hawaii or used Hawaiian datasets [26, 27, 36, 39, 41], and six focused on ethnically diverse populations [26, 27, 36, 39–41], four only on populations in the Pacific Islands [37, 38, 40, 42], and one solely on Native Hawaiians [27]. See Table 1.

5. Breastfeeding Initiation

Four studies examined breastfeeding initiation, three among Hawaiians and one in the Pacific Islands. In the first study, an initiation rate of 29.0% for Hawaiian mothers was observed as compared to 26.0% Caucasians and 50.0% Japanese [36]. In the second study, a 52.6% breastfeeding rate at hospital discharge was observed for Native Hawaiian women as compared to 70.4% Caucasian, 55.4% Japanese, and 33.3% Filipino [39]. In the third study, a 1-month initiation rate of 91.0% was observed for Native Hawaiian mothers attending WIC clinics [27]. Finally, among Pacific Islanders, all mothers on Honiara and Nggela-Sandfly breastfed their children [37]. The results of the meta-analysis indicated that less than half of mothers initiated breastfeeding (M = 46.5%, 95% CI (26.9–66.1), $I^2 = 95.22$).

6. Exclusive Breastfeeding

Six studies reported on EBF [26, 27, 38, 40–42] with three in Hawaii and three in the Pacific Islands. The first study among only Native Hawaiians, reported 3- and 6-month EBF rates of 29.0% and 18.0%, respectively [27]. The second study showed a 31.8% EBF rate among Hawaiian mothers as compared to 51.9% White, 38.0% Korean, 37.0% Black, 33.8% Chinese, 29.4% Japanese, 28.9.4% Filipino, and 24.2% Samoan [26]. The third study found an 18.4% EBF rate among Hawaiians

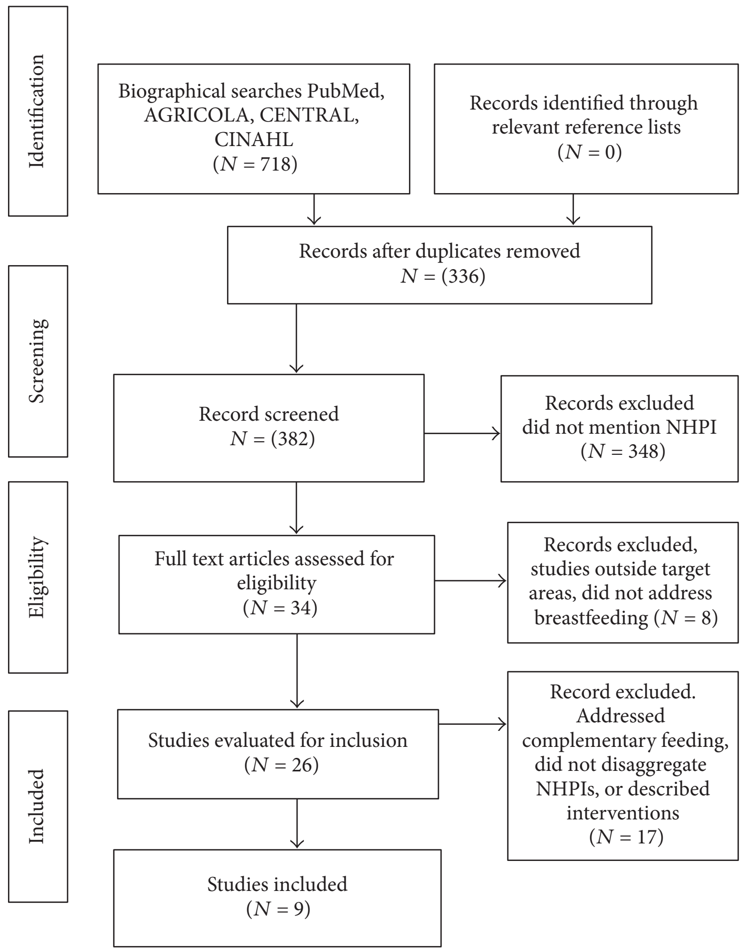

Figure 1: Prisma flow diagram of selected studies.

but did not disaggregate the data by ethnicity [41]. The fourth study in Fiji reported EBF rates of 68.5% at 3 months [40]. However, a decline was shown from 60.2% in 1977 to 45.6% in 1980. The fifth study in Kiribati reported EBF rates of 92.0% at 4 months [38]. The final study in the Commonwealth of the Northern Mariana Islands also found a decline in EBF rates with 46.0%, 23.0%, 26.0%, and 9.0% of children exclusively breastfed for 0–2 months, 2–4 months, 4–6 months, and 9 or more months, respectively [42]. Meta-analysis results showed that less than half of mothers reported EBF practices (M = 40.8%, 95% CI (17.8–63.7), I^2 = 99.74).

7. Breastfeeding Duration

Four studies in our review measured breastfeeding duration, three among Pacific Islanders and one among Native Hawaiians. The first study observed that 45.7% of all infants in Kiribati were breastfed at 12 months [38]. The second study among mothers in the Commonwealth of the Northern Marianas Island reported that 22.0% received breastmilk for 12 or more months [42]. The third study [37] mentioned that most mothers in both Honiara and Nggela-Sandfly were breastfeeding at 6 and 12 months. The fourth study in Oahu [27] reported a 6-month breastfeeding duration rate of 52.0% for all mothers. Due to the variability in measures of breastfeeding duration a meta-analysis could not be appropriately performed.

8. Discussion

The high incidence of obesity, low breastfeeding rates, and other chronic diseases among NHPI makes it imperative to study differences in breastfeeding practices in these populations. Our review found that breastfeeding practices among NHPI are heterogeneous, highlighting disparities in breastfeeding practices among certain NHPI subgroups [26]. Examining breastfeeding practices among NHPI can expose hidden health issues and trends, making it possible to unearth disparity [45].

Our systematic review yielded only nine studies spanning a 44-year period. Moreover, we found limited disaggregated data in national surveys and surveillance systems for these groups. We found no studies examining breastfeeding patterns and disaggregating data for NHPI in the US where approximately two-thirds of NHPI reside [34]. The NHPI population is a young population that is expected to increase

Table 1: Description of selected studies.

Authors, year	Type of study	Sample by location/region and demographics	Measures (breastfeeding initiation, duration, and exclusive)	Results (main outcomes and/or effect sizes)
Brown and Adelson, 1969 [36]	Cross-sectional study	Honolulu, Hawaii (mothers and children) Ethnically and socioeconomically diverse Caucasian, Hawaiian, Japanese, and other populations; Low and middle income; Age (mean): children = 2-3 years; Low income mothers = 28.4 years; Middle income mothers = 29 years; *N* children = 281 *N* mothers = 249	*Indicators: initiation and duration* Initiation: ever breastfed Duration: breast fed for at least 6 months	Approximately one-quarter of the women breastfed their infant. More middle than low income mothers breastfed Ever breastfed: 25.0% of all infants (26.0% Caucasians; 50.0% Japanese; 29.0% Hawaiian; 32.0% other populations) Breastfed at 6 months: 80.0% all infants
Jansen, 1979 [37]	Cross-sectional study	Honiara and Nggela-Sandfly, Solomon Islands, Pacific Islands (mothers) Ethnicity: Pacific Islanders Age (mean): Honiara = 28.3 years; Ngella-Sandfly = 30.7 years *N* = 189 (Honiara = 100, Ngella-Sandfly = 89)	*Indicators: initiation and duration* Initiation: ever breastfed Duration: breastfed for at least 6 months; breastfed for at least 12 months	All mothers from Honiara and Nggela-Sandfly breastfed their infant on the first day after delivery. Early weaning before 6 months was uncommon Ever breastfed: 99.5% Breastfed for at least 6 months: Honiara = 85.7%; Nggela-Sandfly = 93.3% Breastfed for at least 12 months: Honiara = 78.6%; Nggela-Sandfly = 92.3%
Franks and Jurgensen, 1985 [38]	Cohort study	Kiribati, Abemama Atoll Village Clinic (children) Ethnicity: Pacific Islanders *N* = 50	*Indicators: exclusive breastfeeding and duration* Exclusive breastfeeding: exclusive breastfeeding for 4 months Duration: breastfed for 12 months	Most children were breastfed for the whole of their first 4 months of life. Just under half were still being breastfed at 12 months Exclusive breastfeeding for 4 months = 92.0% Breastfed for 12 months = 45.7%
Suganuma et al., 1988 [39]	Cross-sectional study	Oahu, Hawaii (mothers) Ethnically diverse: Caucasian = 37.9%; Hawaiian = 20.3%; Filipino = 10.1%; Japanese = 13.2%; other populations = 18.3% Age = not reported *N* = 562	*Indicator: exclusive breastfeeding* Breastfed only at hospital discharge	Over half of the total sample reported exclusively breastfeeding their infant at hospital discharge. Infant feeding pattern varied considerably by ethnic group. The incidence of exclusive breastfeeding at hospital discharge was the highest among Caucasians and lowest among Filipinos. Just over half of Hawaiians breastfed Breastfed only at hospital discharge: total = 57.5%; Caucasian = 70.4%; Hawaiian = 52.6%; Filipino = 33.3%; Japanese = 55.4%; other populations = 51.5%

TABLE 1: Continued.

Authors, year	Type of study	Sample by location/region and demographics	Measures (breastfeeding initiation, duration, and exclusive)	Results (main outcomes and/or effect sizes)
Lambert and Yee, 1981 [40]	Panel study	Suva, Fiji (infants) Ethnically diverse: Fijian, Indian, and other populations Age = 0–18 months N = varied depending on year of study	*Indicator: exclusive breastfeeding* Breastfed only for at least 0–3 months; breastfed only for at least 4–6 months	The extent of breastfeeding declined over the period 1977–1980 among Fijians as well as other ethnic groups Breastfed only for at least 0–3 months: Fijian 68.5%; Indian 33.8%; other populations 43.7% Breastfed only for at 4–6 months: Fijian 48.4%; Indian 26.2%; other populations 19.3%
Kieffer et al., 1997 [41]	Cross-sectional study (utilizing The Nutrition Survey)	Hawaii (mothers) Ethnically diverse: Filipinos US born (2.8%); Filipinos Philippines born (3.8%); Hawaiian (18.4%); Japanese (14.4%); Other/mixed populations (19.2%); White (41.3%). Age = 27–30 years N = 2013	*Indicator: exclusive breastfeeding* Breastfeeding only at hospital discharge	Mothers who breastfed were more likely to be white, older, married, and educated, have chosen their feeding method prior to pregnancy, and were primarily concerned with the health of their infant as a reason to breastfeed Exclusive breastfeeding among Hawaiians = 18.4% Data not disaggregated by ethnicity
Dodgson et al., 2007 [27]	Cross-sectional study utilizing WIC data	Oahu, Hawaii Ethnicity: Native Hawaiians Age (mean) = 26.71 years N = 200	*Indicator: exclusive breastfeeding and duration* Exclusive breastfeeding: any breastfeeding at 1 month; any breastfeeding at 6 months Duration: exclusively breastfed for at least 3 months; exclusive breastfeeding for at least 6 months	A small amount of women breastfed their infant exclusively for 6 months. Mothers who breastfed exclusively at initiation were significantly more likely to breastfeed for 6 months than women who partially breastfed at initiation. Most Native Hawaiian women combined exclusive breastfeeding and partial breastfeeding. More multiparous than primiparous women exclusively breastfed at initiation Any breastfeeding at 1 month = 91.0%; any breastfeeding at 6 months = 52.0%; exclusively breastfed at least 3 months = 29.0%; exclusive breastfeeding at least 6 months = 18.0%
Novotny et al., 2007 [42]	Univariate descriptive study	Commonwealth of the Northern Mariana Islands (children) Ethnicity: Pacific Islanders Age = 6 months to 10 years N = 420	*Indicators: exclusive breastfeeding and duration* Exclusive breastfeeding: Exclusive breastfeeding for 0–2; 2–4; 4–6; and 6 or more months Duration of breastfeeding: breastfed for 9 to 12 months; received breastmilk for 12 or more months	Over three-quarters of the children were breastfed, while just over half were breastfed at 6 months. A smaller percentage was still being breastfed at one year Exclusively breastfed: 46.0% were exclusively breastfed for 0–2 months; 23.0% were exclusively breastfed for 2–4 months; 21.0% were exclusively breastfed for 4–6 months; 9.0% were exclusively breastfed for 6 or more months; 15.0% were breastfed for 9–12 months; 22.0% received breastmilk for 12 or more months

Table 1: Continued.

Authors, year	Type of study	Sample by location/region and demographics	Measures (breastfeeding initiation, duration, and exclusive)	Results (main outcomes and/or effect sizes)
Hayes et al., 2014 [26]	Cross-sectional study by PRAMS data	Hawaii (mothers) Ethnically diverse: Caucasian = 21.3%; Native Hawaiian = 27.6%; Samoan = 2.9%; Filipino = 18.3%; Japanese = 12.2%; Chinese = 3.6%; Korean = 1.6%; Black = 2.4%; other populations = 10.2% Age = 20–35 years N = 8082	*Indicator: exclusive breastfeeding* Exclusive breastfeeding at 8 weeks	There was a difference in the rates of exclusive breastfeeding by ethnic group. White mothers had the highest estimate followed by Korean and Black mothers. Disparity in exclusive breastfeeding rates was observed among NHPI subgroups 36.3% of all mothers exclusively breastfed for at least 8 weeks (Caucasian = 51.9%; Native Hawaiian = 31.8%; Samoan = 24.2%; Filipino = 28.9%; Japanese = 29.4%; Chinese = 33.8%; Korean = 38.0%; Black = 37.0%; Other = 41.7%)

exponentially by the year 2060 [46, 47], and it is also critical that mandates related to disaggregating NHPI data by distinct ethnic and racial groups separate from Asian Americans are implemented [34, 46]. There is a need to enhance the monitoring of breastfeeding practices in all US NHPI states, territories, and commonwealths to better identify risk factors for poor breastfeeding outcomes.

In addition, we found that varying terms and time periods were used for breastfeeding initiation, exclusivity, and duration among studies in our review. Such variations have also been observed among federally funded datasets, indicating a need for standardization of breastfeeding outcomes [45]. Future studies should implement consistent terminology for the purpose of comparing effects and replicating studies. In addition, it is important that studies use time frames (breastfeeding at 6 and 12 months and exclusive breastfeeding at 3 and 6 months) that are aligned with national objectives and national data collection and monitoring systems.

The result of our meta-analysis indicated that less than half of NHPI women initiated breastfeeding or breastfed exclusively. These pooled analyses show that NHPI breastfeeding practices are below the *Healthy People* 2020 goals. Qualitative studies have highlighted several factors that may affect breastfeeding practices among NHPI, namely, lack of knowledge, lactation problems, poor family and social support, social norms, embarrassment related to breastfeeding in public, employment and child care issues, and the education of health care providers, so that they can fully support the breastfeeding efforts of NHPI mothers [35, 48, 49]. Further research needs to be conducted to determine the reasons for the disparity in breastfeeding practices. We suggest, at a minimum, disaggregating survey data by the race/ethnicity in order that future analyst can use such data. Our search produced neither randomized nor quasirandomized controlled trials related to breastfeeding among NHPI. Studies are also needed to systematically explore the types of interventions that can enhance exclusive breastfeeding rates and duration among NHPI.

There are few important considerations that need to be noted in interpreting the findings of this review. The unclear definitions of breastfeeding terms, variability in the measurement periods, and the small number of studies are limitations. However, despite these concerns, the need for this study cannot be overemphasized as it illuminates disparities within the NHPI populations and brings to light the needs of a group that could potentially remain on the outskirts of policy decisions and focus.

9. Conclusion

Future studies should work to disaggregate NHPI data and identify barriers to breastfeeding among NHPI. Moreover, multicomponent, multilevel strategies directed toward NHPI communities are needed to support breastfeeding practices. Such studies can support existing culturally appropriate practices, advance health promotion activities, and provide directions for policies to minimize health-related morbidity, mortality, and disparities among the NHPI population.

Competing Interests

No competing financial interests exist.

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Research Article

Design of a Digital-Based, Multicomponent Nutrition Guidance System for Prevention of Early Childhood Obesity

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Interventions targeting parenting focused modifiable factors to prevent obesity and promote healthy growth in the first 1000 days of life are needed. Scale-up of interventions to global populations is necessary to reverse trends in weight status among infants and toddlers, and large scale dissemination will require understanding of effective strategies. Utilizing nutrition education theories, this paper describes the design of a digital-based nutrition guidance system targeted to first-time mothers to prevent obesity during the first two years. The multicomponent system consists of scientifically substantiated content, tools, and telephone-based professional support delivered in an anticipatory and sequential manner via the internet, email, and text messages, focusing on educational modules addressing the modifiable factors associated with childhood obesity. Digital delivery formats leverage consumer media trends and provide the opportunity for scale-up, unavailable to previous interventions reliant on resource heavy clinic and home-based counseling. Designed initially for use in the United States, this system's core features are applicable to all contexts and constitute an approach fostering healthy growth, not just obesity prevention. The multicomponent features, combined with a global concern for optimal growth and positive trends in mobile internet use, represent this system's future potential to affect change in nutrition practice in developing countries.

1. Introduction

Problems in nutrition and growth in early life have increasingly been implicated in long term health outcomes with devastating consequences to human capital. Undernutrition's effects in early life are well documented and culminate in increased growth faltering, morbidity, and mortality as well as impairment in cognitive development and diminished work capacity in adulthood [1, 2]. These negative effects are best prevented in the first 1000 days of life, as attempts to treat after that time are less effective [3].

A parallel scenario is surfacing related to overweight and obesity in early life. Current research supports consistent associations of maternal weight gain during gestation, large for gestational age birth size, and rapid weight gain during infancy with BMI, adiposity, or risk of overweight/obesity in childhood through adulthood [4–6]. Consequences of rapid weight gain in infancy are also linked to adverse cardiovascular and metabolic outcomes later in life [7–10]. At present, efforts to prevent and treat obesity during childhood have mixed success [11, 12]. Thus, prevention of both over and undernutrition is a global concern, with interventions beginning during the first 1000 days of life.

Results from intervention trials for prevention of early childhood obesity within the first two years of life are limited [11, 13–15], and few begin during gestation. Although three large randomized controlled trials (RCT) [16–19] enrolled new mothers to educational interventions with the goal of early obesity prevention, results ranged from a significant 0.29-unit decrease in BMI at 2 years [16] and lower BMI z-scores plus decreased odds of rapid weight gain at 13.7 months but not at 2 years [18, 19] to no significant difference in BMI z-score at 20 months [17]. Even for the trials that found significant effects at 2 years, those effects diminished by 5 years with no further intervention [20, 21]. Following these first efforts with mixed results and to potentially achieve a greater effect size, theoretically driven interventions that increase the likelihood of sustainability are needed.

High rates of overweight also urge a focus on developing scalable interventions that reach children prior to the onset of either insufficient or excess weight gain [11]. Globally, 6.1% of children aged 0–5 years are overweight or obese (proportion of children with weight-for-height above 2 standard deviations) [22], and projections indicate an increase to 9.9% in 2025 [2]. In the US, 7.1% of children aged 0–2 years have weight-for-length >95th percentile and the prevalence of overweight or obesity is 22.8% among children aged 2–5 years [23]. Therefore, there is need for innovative and effective interventions with delivery mechanisms that can be disseminated to the wider population.

Digital-based interventions are increasingly feasible for such scale-up efforts. These web and mobile-based programs help to avoid the limitations of prior interpersonal interventions which often affect coverage, dose, and fidelity [24–29]. Parents, especially mothers, spend a significant amount of time on the internet and frequently use it to seek parenting and child health related information [30–32]. Thus, the target population would be familiar with such a format to deliver this type of intervention.

The objective of this paper is to provide a detailed description of a digital-based, multicomponent nutrition guidance system designed to improve feeding and related practices by first-time mothers for prevention of obesity and promotion of optimal growth in their children during the first two years of life. This digital-based system is designed to be scaled up to reach all populations in need and be easily adapted to accommodate varying sociocultural contexts for the prevention of over- and undernutrition during the first 1000 days.

2. Methods

Development of the multicomponent nutrition guidance system for healthy growth and prevention of early childhood obesity was informed by the World Health Organization's (WHO) health education theoretical concepts and strategies [33] and guided by Contento's Procedural Model for Nutrition Education [34] involving four process components: (1) identification of modifiable factors which could be target behaviors; (2) identification of potential mediators; (3) selection and justification of theoretical model; (4) and design of the intervention. We further sought to explore generalizability of the nutrition guidance system and a digital delivery format. An overarching goal for our process was to follow a rigorous method to substantiate all components of the final intervention, from development of educational content to intervention delivery.

Systematic literature reviews were conducted for components 1 and 2. Methods for the literature review to identify target behaviors (i.e., modifiable factors) were previously described by Dattilo et al. [35]. For the identification of potential mediators, inclusion criteria included (1) studies published in English language from January 1, 2000, through September 30, 2012; (2) studies conducted in high income countries; (3) mean age of children in the sample less than 5 years; (4) maternal age ≥ 18 years; and (5) sample size > 10. Literature included peer-reviewed articles, public policy statements, and publically available guidance from the WHO, American Academy of Pediatrics (AAP), and the US government departments of Health and Human Services and Agriculture (DHHS and USDA, resp.).

3. Results and Discussion

3.1. Component 1: Identification of Target Behaviors. The modifiable factors that influence healthy growth of infants defined as dietary, feeding, and care practices and could be addressed in interventions beginning at birth have been previously identified by our group [35]. These modifiable factors formed the basis for the current intervention's target behaviors and were assigned to eight core messages of the nutrition guidance system: (1) provide breastmilk; (2) utilize responsive feeding practices; (3) provide nutritious complementary foods and beverages at the appropriate developmental stage; (4) exclude sugar sweetened beverages; (5) foster healthy eating behaviors through shared family meals and mealtime routines; (6) limit TV and screen viewing time; (7) provide opportunities for physical activity; and (8) ensure that the infant/toddler has adequate sleep.

3.2. Component 2: Identification of Potential Mediators. Potential mediators, defined as underlying determinants that precede behaviors, were identified via systematic literature reviews for each of the aforementioned core messages. The resultant potential mediators and cognitive variables included knowledge, attitudes, beliefs, self-efficacy, social norms, and skills, as well as environmental constraints that influenced whether or not a target behavior was performed. Research findings related to the mediators were summarized onto Research-Based Content Tables for each core message. Findings were summarized and categorized into four types of mediators: knowledge; instruction; facilitator; or barrier.

3.3. Component 3: Selection and Justification of Theoretical Model. Nutrition education interventions use theories from the ecological, social, and psychological sciences to help identify the constructs or mediating variables that influence the behavior of interest [36] and then apply theoretically specified techniques to modify the mediating variables resulting in behavioral adoption [37–39]. Social Cognitive Theory (SCT), Theory of Planned Behavior (TPB), and the Health Belief Model (HBM) were selected for the multicomponent feeding guidance program based on their application in observational and qualitative studies [40–51] and successful implementation within intervention trials [17, 19, 52–55] related to infant, toddler, and preschool-aged feeding behaviors, as well as their strengths in promoting motivation to perform behavior (Theory of Planned Behavior and Health Belief Model) and supporting capacity to act on the behavior (Social Cognitive Theory) [56]. SCT has been successfully incorporated within

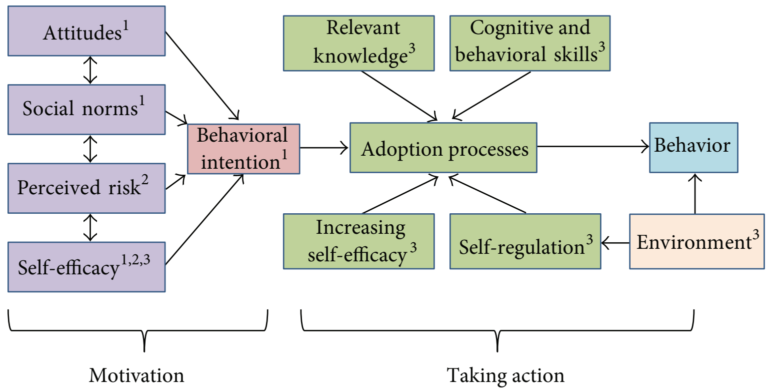

Figure 1: Theoretical model for the nutrition guidance system based on (1) Theory of Planned Behavior, (2) Health Belief Model, and (3) Social Cognitive Theory.

interventions to prevent early introduction of solids [31], increase use of positive responsive feeding practices, decrease consumption of sweet snacks, and lower daily television viewing time [17, 19] and is being utilized in upcoming interventions targeted at the early prevention of child obesity [57–60]. The self-efficacy construct from SCT has been found to be predictive of breastfeeding intention and duration [40–43], providing nutritious complementary foods and beverages [44], decreasing sweetened beverage consumption [44], and promoting physical activity while limiting screen time [44].

Constructs from TPB were frequently cited to explain motivation and intention related to the core messages. Constructs such as attitudes, perceived behavioral control, moral norms, and subjective norms have been linked with providing breastmilk [45, 48, 49], provision of nutritious complementary foods at appropriate developmental stage [46, 48, 50], and foster healthy eating through shared family meals and mealtime routines [47]. Thus, those constructs were maintained in the overall theoretical model related to behavioral intention.

The Health Belief Model was included in addition to TPB to increase behavioral intention due to its theoretical framework to understand barriers and facilitators to family meals [51] and its unique constructs of perceived susceptibility and perceived severity [56]. The perceived risk of early childhood obesity is a central component because of prevailing beliefs about larger infants being healthier or better [48, 61, 62], tendencies to practice unresponsive feeding such as pressuring, despite acknowledging infant satiety cues [63, 64], failure to perceive overweight children as overweight [62, 65], and a general belief that young children will grow out of any early overweight or obese status [61, 66].

From the Research-Based Content Tables, each research finding and its classification as knowledge, instruction, facilitator, or barrier were linked to a construct within SCT, TPB, and HBT (Table 1). A detailed theoretical framework for this digital-based nutrition guidance system is shown in Figure 1.

Two additional frameworks, anticipatory guidance and motivational interviewing, were also incorporated. Anticipatory guidance was selected to inform the timing of messages

Table 1: Alignment of theoretical constructs with simplified mediators in research content tables.

	Motivational constructs
Knowledge	(i) Behavioral beliefs[1], outcome expectations[2], perceived benefits[3] (ii) Perceived risk (susceptibility + severity)[2]
Facilitators	(i) Existing positive or strong (a) Behavioral beliefs[1], outcome expectations[2], perceived benefits[3] (b) Outcome evaluations[1], attitudes[1], outcome expectancies[2] (c) Perceived risk[3] (d) Social norms[1], social outcome expectations[2] (e) Self-efficacy[2,3], perceived behavioral control[1]
Barriers	(i) Existing positive or strong (a) Behavioral beliefs[1], outcome expectations[2], perceived benefits[3] (b) Outcome evaluations[1], attitudes[1], outcome expectancies[2] (c) Perceived risk[3] (d) Social norms[1], social outcome expectancies[2] (e) Self-efficacy[2,3], perceived behavioral control[1] (ii) Environmental constraints[2,3]
	Capacity to act constructs
Knowledge	(i) Behavioral capability (relevant background knowledge)[1]
Barriers	(i) Increasing self-efficacy to overcome existing barriers[2] (ii) Self-regulation[2]
Instruction	(i) Behavioral capability[2] (ii) Increase self-efficacy[2]

[1]Theory of Planned Behavior.
[2]Social Cognitive Theory.
[3]Health Belief Model.

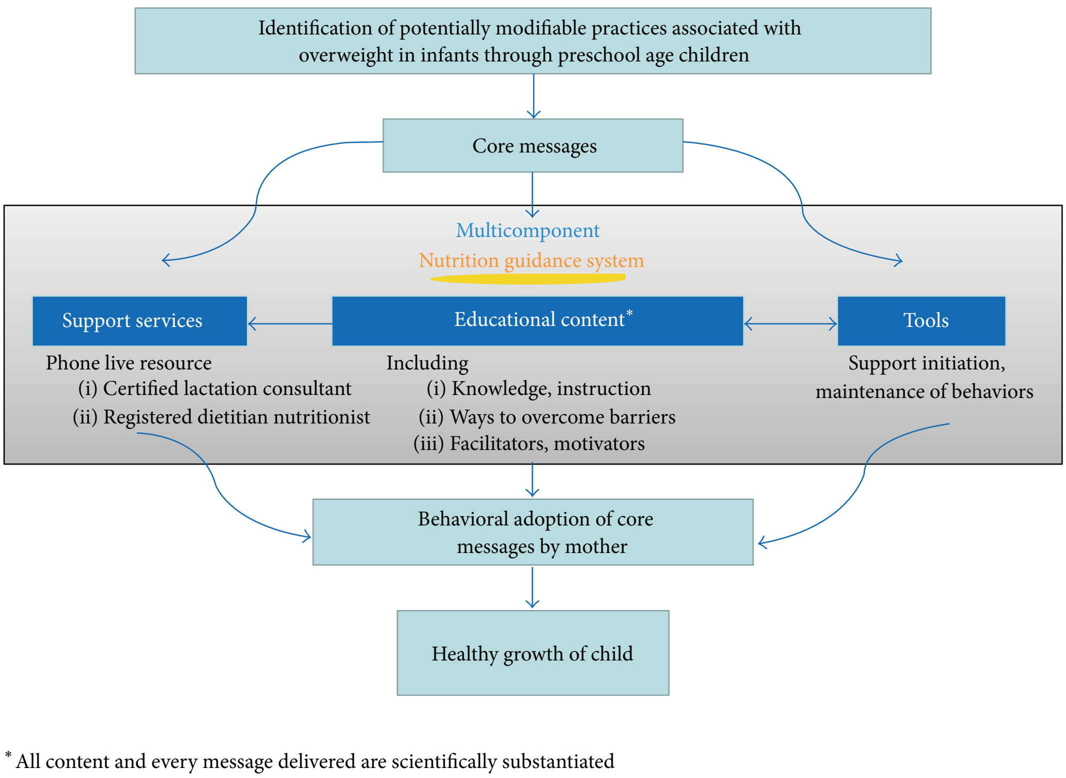

Figure 2: Conceptual framework for the nutrition guidance system.

and content delivery. Since anticipatory guidance is the prevailing framework for pediatric well-visits during childhood in the US [67–69] and previously incorporated within other interventions testing early obesity prevention [17, 19], this approach was included in the multicomponent nutrition guidance system as a method to proactively deliver components of core messages to parents during the period just prior to when the issue will be developmentally relevant to the infant or child. Similarly, motivational interviewing is a client centered communication technique that has been recommended and found effective for treatment of pediatric obesity in clinical settings [70, 71] and fits within the standards of practice for registered dietician nutritionists (RDNs) [72].

3.4. Component 4: Design of Intervention. The multicomponent nutrition guidance system includes digitally based educational content and tools, plus telephone-based professional support from certified lactation consultants (CLC) and registered dietitian nutritionists (RDNs) as depicted in the system conceptual framework (Figure 2). Educational content is intended to provide the required knowledge and instruction as well as address the barriers and facilitators associated with implementing the core messages. The tools are meant to help mothers initiate and maintain behaviors within the core messages. Lastly, the telephone-based professional support is available to help mothers with remaining needs related to adopting the core messages and reinforce content delivered digitally using a motivational interviewing approach. Mothers initiate contact with the CLC or RDN by calling a toll-free number or scheduling an appointment on the website for the CLC or RDN to call them at a certain time. These components are consistent with the theoretical frameworks, and both the educational content and tools are designed to address the underlying theoretical constructs to affect behavioral adoption. The following sections describe the considerations undertaken with regard to development of content and tools, timing of delivery, delivery format, and generalizability to diverse audiences.

3.5. Development of Content and Tools. The intervention content team, composed of Pediatricians, two Ph.D. in nutrition, and Registered Dietitian Nutritionists with expertise in nutrition education and maternal and childhood nutrition formulated the content and delivery timeline for the digital-based intervention. Additional input was incorporated from an academic advisory board, consumer communications professionals, and a creative agency group regarding aesthetic layout and digital framework.

The content and tools include articles, emails, videos, quizzes, infographics, printable and interactive trackers, and a goal setting tool and were developed to constitute the theoretically specified techniques to address the constructs of SCT, TPB, and HBM and influence behavioral adoption (Table 2) [37, 56, 73].

Utilizing a rigorous process to develop the written copy and ensure thorough substantiation of all included content, the first step within content development was to complete the Research-Based Content Tables for each of the 8 core messages which included research findings related to underlying behavioral determinants of each core message. Content was

Table 2: Examples of intervention features for behavioral adoption.

Theoretical constructs	Theoretical techniques	Intervention examples
Behavioral beliefs, social norms, perceived risk	(1) Provide information on consequences (2) Provide normative information about others' behaviors	(i) Article on benefits of breastfeeding (ii) Articles mentioning recommendations from AAP and other groups (iii) Article describing statistics about breastfeeding (iv) Slideshow with picture of average parents role modeling healthy eating
Outcome evaluations, attitudes	(1) Acknowledgement of feelings, motivations (2) Emotion-based messages	(i) "I promise" statement to help mothers articulate their commitment to their baby and why
Self-efficacy and improving self-efficacy via social modeling, mastery experiences, social persuasion	(1) Barrier identification (2) Model/demonstrate the behavior (3) Provide general encouragement (4) Prompt goal setting	(i) Article on common challenges during breastfeeding (ii) Video of breastfeeding mother (iii) Encouraging text messages and statements within articles (iv) Goal setting tool
Relevant knowledge	(1) Feeding and nutrition knowledge	(i) Article on how breastmilk is produced (ii) Glossary to define terms
Behavioral capability	(1) Provide instruction (2) Demonstrate the behavior	(i) Video of woman demonstrating how to latch a baby onto her breast (ii) Stills of how to swaddle a baby (iii) Table showing suggested bottle volumes by age (iv) Step-by-step instructions for introducing solid foods
Self-regulation	(1) Prompt goal setting (2) Prompt self-monitoring of behavior (3) Stress management	(i) Growth tracker (ii) Goal setting tool (iii) Baby/family simplified meal planner (iv) Call to action where mothers are prompted to upload photo of their child doing one of the core messages (v) Breastfeeding tracker (vi) Taste tracker (vii) Article on taking care of oneself after delivery (viii) Articles reminding mothers to reach out to social support system (ix) Tone that recognizes all emotions are normal

divided into 13 different modules to be regularly delivered over the course of the first two years, with the first module delivered prenatally. The second step was to prioritize up to 10 messages per core message from the content tables as priority messages to be emphasized within each of the modules. Each message was scheduled for when it would be presented to mothers as a preview in a module, when it would be discussed at length, and when it would be reviewed in later modules. This schedule or cadence of messages allowed for quick review to ensure appropriate timing and adequacy of emphasis within the intervention. The last step was creation and approval by the intervention team of final copy decks including headlines, subheadings, full copy, and photo image files to directly populate the website pages. Consideration was made with regard to scientific accuracy, adherence to nutrition education constructs, appropriate reading level (average no greater than 8th grade) [74, 75], and tone.

Emails, developed by the intervention team, were scheduled to be sent to notify mothers when the next module was available for viewing and to periodically remind mothers of assets in the current learning module to encourage them to visit the website. Text messages are also sent to mothers who have opted to receive them, and the texts reinforce messages from the current educational module and encourage mothers to visit the website. Emails and text messages are programmed to be automatically sent from the system based on the infant's birthdate and other pieces of personal information from the dyad's profile stored in the website database.

The tools were developed to increase behavioral capacity and self-regulation, constructs from SCT affecting the ability

Table 3: Core messages and timing of delivery to provide anticipatory guidance.

Core messages	Third trimester	Birth	2 mo	4 mo	6 mo	8 mo	10 mo	12 mo	14 mo	16 mo	18 mo	20 mo	22 mo
Provide breastmilk	√	√	√	√	√	√	√						
Utilize responsive feeding practices	√	√	√	√	√	√	√	√	√	√	√	√	√
Provide nutritious complementary foods and beverages at the appropriate developmental stage			√	√	√	√	√	√	√	√	√	√	√
Exclude sugar sweetened beverages for infants and limit for toddlers				√	√	√	√	√	√	√	√	√	√
Foster healthy eating behaviors through shared family meals and mealtime routines					√	√	√	√	√	√	√	√	√
Limit TV and screen viewing time				√	√	√	√	√	√	√	√	√	√
Provide opportunities for physical activity		√	√	√	√	√	√	√	√	√	√	√	√
Ensure that the infant and toddler have adequate sleep	√	√	√	√	√	√	√	√	√	√	√	√	√

to take action and maintain newly adopted behaviors [56]. The interactive digital tools include an interactive growth tracker, a goal setting tool, and a menu planner. The growth tracker supports self-monitoring or in this case "maternal-monitoring" and allows mothers to input their child's weight and length at any point, and the tracker will plot the child's weight-for-length percentile. If a child's weight-for-length percentile is outside of the 5th–85th percentile for healthy growth and/or has crossed two percentiles, the mother will see a pop-up box with copy suggesting that she consult her child's health care provider. Accuracy of measurements is not ensured, but instructions on the growth tracker will include suggestions to use measurements taken at health care provider visits so this tool can be used to review a child's progress over time at home. The goal setting tool is designed to assist mothers in achieving self-directed larger goals via performance of smaller tasks [76]. A menu planner allows for the mother to plan meals for the week by accessing a list of nutritious meal and snack options and adding them to different days of the week. The menu planner can change from infant only use to a family meal planner as the infant transitions to family foods as a way to prompt parents to model healthy eating for their child during family meals and to ensure continued provision of nutrient dense meals and snacks to the child [77]. Noninteractive, printable tools are available as well including a breastfeeding tracker, diaper tracker, and taste tracker (to track number of exposures to new foods and baby's reactions).

3.6. Sequence of Educational Content Delivery. Based on the anticipatory guidance framework [67], a sequential and anticipatory timing of delivery was incorporated. The educational content and tools are delivered approximately every two months for a total of 13 intervention modules known as "Building Blocks." Building Blocks are delivered during the third trimester of pregnancy, soon after birth, and every 2 months thereafter until the child is 22 months of age. At enrollment in the intervention, future Building Blocks are locked from viewing until the child reaches the appropriate age-based stage in order to focus maternal attention on the necessary content for the child's current age (Table 3). The option for consultation with RDN and/or CLC is encouraged throughout the intervention.

3.7. Delivery Format. The nutrition guidance system utilizes only digital-based vehicles for delivering the educational content and tools. A website is the repository of all the content and tools and houses an online-scheduling system for making appointments with the professional support team. The website is optimized for use on a mobile device.

Previously, only person-to-person formats (including clinic-based, group education-based, and home-based) have been utilized in interventions to promote healthy growth and appropriate dietary, feeding, screen time, and sleep behaviors among the 0–2-year-old population. While studies have had some success in affecting weight status [13, 16, 18, 78] and behaviors [14–18, 69, 79], these person-to-person delivery formats have limitations which make national and global scale-up time consuming, resource draining, and potentially less effective. Clinic-based interventions can be limited by lack of provider time [24, 80–82], inadequate provider training in nutrition counseling [24–26], and beliefs that public health education is not part of the provider's scope of work [24, 25, 27]. Group education settings have been plagued by low attendance either due to lack of transportation and childcare [28, 29] or inability to coordinate schedules around work or school [19, 29]. Finally, while home-based interventions, usually consisting of a trained nurse visiting the family home, are the most intensive intervention delivery method, they also require the most resources including hiring, training, and supervising a large staff plus travel costs for individual home visits. Thus, scale-up would entail a high cost in order to overcome these limitations and achieve sufficient coverage, dose, and fidelity needed to maintain effectiveness of the intervention.

Digital-based interventions are likely to be an effective and acceptable alternative for the target population. Digital-based interventions have been effective for behavior modification in adult populations including interventions targeting diet, physical activity, and weight [83–86]. Utilization of theory and behavior change techniques also enhances their effectiveness [73, 86, 87]. Although several digital-based interventions have targeted this population of parents and child, only one has explicitly focused on prevention of overweight in 0–2-year-old children. Denney-Wilson et al. are currently testing a website and smartphone app-based intervention to improve infant feeding and parenting behaviors among socioeconomically disadvantaged parents of infants aged 0–9 months in Australia [88]. Interventions have addressed breastfeeding [89, 90], newborn care [90, 91], parenting [90], maternal fruit and vegetable consumption [92], and toddler safety [93]. Digital-based education is also used in national maternal and child health programs such as https://www.wichealth.org/ for the Supplemental Nutrition Program for Women, Infants, and Children (WIC) [94] and the Text4Baby program [95] in the United States and the Hello World email-based program in Netherlands [96, 97].

General media trends indicate rapid, consolidated movement towards use of digital over print. As of January 2014, ninety-seven percent of adults in the US aged 18–29 and 93% of adults aged 30–49 were internet users [98]. Eighty-five percent of 18–29-year-old adults own smartphones, and more African Americans and Hispanic Americans own smartphones than White Americans demonstrating that this trend reaches multiple sectors of the population [99]. Internet was the only media (including magazines, newspapers, TV, radio, internet, email, and cell phone) which women increased their use of after becoming mothers [31]. Additionally, mothers spend twice as much time online as the general population [31].

Research also points to greater parenting-related and health information seeking online further indicating likely acceptance of the digital format. More than half of mothers surveyed sought parenting-related information from digital sources [31], and 76% said that they look up parenting advice monthly or more often on their mobile device or tablet [30]. Previous studies have found that younger mothers, especially first-time mothers, are more likely than older and experienced mothers to use and trust the internet to find pregnancy, parenting, and health information [32, 74, 100]. Lower income, single mothers may have greater online health information seeking behaviors because they may be more isolated and without family to provide support [74].

A well-designed digital intervention has the potential to be cost-effective compared to other delivery formats. The likelihood that our digital-based nutrition guidance system is effective at engaging this demographic and achieving behavioral adoption is high. Additionally, the bulk of the cost comes from the development of the digital system, which are nonrecurring, thereby leaving only minimal costs related to maintenance as the intervention is scaled up and new users are added [101].

3.8. Generalizability to Diverse Audiences. The target audience for this nutrition guidance system is first-time mothers in the United States. This system is intended to be applicable for a wide-range of income and educational levels as well as sociocultural groups and geographical locations. When reviewing the potential mediators of target behaviors, we included literature to capture a range of demographics, including specific subpopulations such as low income, WIC participants, and/or predominantly minority groups. The thorough review allowed us to identify those mediators which tended to be generalizable to all groups, and we focused our priority messaging around such mediators. Indeed, much of the research findings were generalizable to most groups. However, research findings that were too specific to a particular group were not included in final content. We maintained scientific accuracy of the content, by prefacing in the copy which population group was in the study. Finally, all photos on the website and emails were purposively selected to depict a diverse population.

Many studies target specific subpopulations of interest for a variety of factors including potential to benefit, research based on social welfare programs, and other existing relationships established with that population. Childhood obesity studies have often focused and continue to focus on subpopulations such as low income families [58, 102–106], particular racial/ethnic groups [102, 107–109], and children with overweight/obese mothers [59, 106, 110]. Healthy growth is important for all populations, and problems with overweight and obesity affect all race/ethnicities and socioeconomic groups. Scalability will require generalizability beyond previously studied subpopulations. New interventions will need to be developed with generalizability in mind and tested among the broader population such as our nutrition guidance system. However, cultural appropriateness will also be assessed using process measures as the intervention is rolled out and evaluated.

This multicomponent nutrition guidance system, based on its core characteristics, also has the capacity for dissemination to global contexts where undernutrition is prevalent. The rates of undernutrition remain high and the rates of obesity are rising in low and middle income countries (LMIC) [2]. The core messages targeting modifiable factors associated with obesity in essence support optimal growth, and many are comparable to the infant and young child feeding (IYCF) practices targeted for prevention of undernutrition. The rising obesity rates, potentially due to the nutrition transition and greater urbanization of LMIC, demand incorporation of physical activity, avoidance of sedentary behaviors, and adequate sleep into the global framework for achieving optimal child nutrition and development [2, 111]. To modify these behaviors, the identification of context specific mediators is the universal characteristic rather than any mediators themselves as context specific messages will likely enhance behavioral adoption more than general messages [112, 113]. Theory-based interventions are not common in global IYCF interventions but have shown success when used [114, 115]. Therefore this system will greatly contribute to the small evidence base of theory-based interventions in LMIC. Digital-based interventions are becoming more feasible with rising penetration of mobile and mobile broadband use in LMIC [116–118] and hold promise for greater coverage and cost effectiveness similar to other mobile health efforts [119–123]. Lastly, this system delivers education only, which means that there will be neither reliance on sustainable delivery of a product nor any violation of the International Code of Marketing of Breastmilk Substitutes. Ultimately, this multicomponent nutrition guidance system, due to this set of core characteristics, has a unique opportunity to address a majority of nutrition priorities found in LMIC and other global contexts.

3.9. Strengths and Limitations. The final set of characteristics for this multicomponent nutrition guidance system represents the strengths in the intervention design. First, the target behaviors are scientifically based on the most current understanding of potentially modifiable behaviors associated with childhood obesity and their underlying mediators. Second, the intervention has a theoretical foundation in the Social Cognitive Theory, Theory of Planned Behavior, Health Belief Theory, anticipatory guidance, and motivational interviewing. Third, the educational content and tools are delivered in a developmentally appropriate and sequential order. Fourth, the system is designed to engage a broad audience to ensure maximum applicability and scalability. Fifth, the delivery vehicles are digital which reflects the current communication and media trends and offers potential for greater cost effectiveness. Lastly, the system and its characteristics are designed to be generalizable for opportunities to disseminate to other global contexts.

The primary limitation to the design of this nutrition guidance system was the lack of formative research and pilot testing to guide the development of the intervention. The thorough review of the qualitative literature and existing formative research helps to mitigate this limitation as it captured many of the experiences of the target audience around the core messages to the point of saturation. As mentioned previously, prior to implementation in other populations, context specific mediators will need to be identified during additional formative research and pilot tested. Other related digital-based systems have been found acceptable and feasible in this population within Western cultures as well as Asian cultures [124–128]. Based on other formative and pilot research, mothers often appreciate personalized communication tailored to milestones [125, 127], not too frequent text messages with the ability to opt out [125, 127], email reminders [127], and content that is not alienating to mothers who are not breastfeeding [125]. Health care providers are reported to find digital systems acceptable as long as the content supports the recommendations they would give women and new mothers [124, 125]. As mentioned previously, our intervention content team and advisory board, who reviewed the entire intervention, included several health care providers, primarily Pediatricians, and Registered Dietitian Nutritionists. Much of the content was developed based on current recommendations from major health organizations such as the American Academy of Pediatrics. As the intervention was developed with evidence from other formative and pilot research and in line with current, standard pediatric practice, we anticipate that the digital-based system would be acceptable and feasible within our target population.

4. Conclusion

A multicomponent nutrition guidance system designed and implemented as described constitutes a comprehensive intervention approach to address modifiable factors associated with early onset of childhood obesity and promote optimal growth. The rigorous method by which it was designed incorporates best practices for intervention, and this thorough description allows new users to adapt the system as necessary. The digital delivery format offers a cost-effective means to deliver the intervention in a manner that fits within the lifestyle of new mothers. Upon successful evaluation with an adequately designed clinical trial, this system can be scaled up to the proportions necessary to affect real and sustainable change in the goal to promote healthy nutrition and growth in the first 1000 days.

Competing Interests

The authors declare that there are no competing interests related to the publication of this paper.

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Research Article

Let's Wiggle with 5-2-1-0: Curriculum Development for Training Childcare Providers to Promote Activity in Childcare Settings

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Overweight and obesity are increasing in preschool children in the US. Policy, systems, and environmental change interventions in childcare settings can improve obesity-related behaviors. The aim of this study was to develop and pilot an intervention to train childcare providers to promote physical activity (PA) in childcare classrooms. An evidence scan, key informant ($n = 34$) and focus group ($n = 20$) interviews with childcare directors and staff, and environmental self-assessment of childcare facilities ($n = 22$) informed the design of the training curriculum. Feedback from the interviews indicated that childcare providers believed in the importance of teaching children about PA and were supportive of training teachers to incorporate PA into classroom settings. The *Promoting Physical Activity in Childcare Setting Curriculum* was developed and training was implemented with 16 teachers. Participants reported a positive experience with the hands-on training and reported acquiring new knowledge that they intended to implement in their childcare settings. Our findings highlight the feasibility of working with childcare staff to develop PA training and curriculum. Next steps include evaluating the curriculum in additional childcare settings and childcare staff implementation of the curriculum to understand the effectiveness of the training on PA levels of children.

1. Introduction

Overweight/obesity has become a critical public health concern in the United States [1]. Initiatives to address overweight and obesity include efforts at the state level and within local communities [2]. In 2014, the State Surgeon General for Florida identified overweight and obesity as the number one public health threat in the state, with only 36% of Floridians at a healthy weight [3]. Rates of overweight and obesity in preschool children have increased over the past 20 years, with approximately one in three children in Florida now identified as overweight or obese [3]. Estimates suggest that six out of ten children born in Florida will be obese by 18 years old. The state of Florida has responded to this public health threat with Healthiest Weight Florida, a public-private collaboration of state agencies, nonprofit organizations, businesses, and community-wide efforts [4]. This initiative has promoted regional and county efforts to disseminate best practices to encourage healthy eating and active living as a strategy to decrease chronic disease risks associated with obesity.

In Northwest Florida (NWFL), the local health department implemented *"5-2-1-0 Let's Go!"* in January 2014. This county-level approach for achieving healthy weight in children was based on Let's Go! Maine, a multisetting community-based obesity prevention program which successfully increased children's consumption of fruits and vegetables, decreased children's intake of sugary drinks, and increased parent awareness of the program [5]. The strategy included delivering a messaging campaign with four recommendations: "eat five or more fruits and vegetables each day," "limit daily recreational screen time to two hours or less," "engage in one or more hours of physical activity daily," and "consume zero sugary drinks; drink water or low fat milk." This comprehensive campaign highlighted the 5-2-1-0 message with advertising on community buses, commercial outdoor signs, a short cartoon video aired in movie theaters, and social media marketing strategies. Additionally, the local health department targeted selected populations to implement community-based programming. With >60% of three- and four-year-olds enrolled in childcare [6] and 34% of preschoolers and students in grades 1–3 overweight or obese [7], it was determined that intervention efforts should focus on childcare settings to reduce early onset of overweight and obesity.

In addition to the *"5-2-1-0 Let's Go!"* campaign [5], there is strong evidence that a combination of nutrition and physical activity interventions in preschool and childcare settings can improve children's diets and levels of physical activity [8–11]. The Institutes of Medicine [12], US Surgeon General [1], Centers for Disease Control and Prevention [13, 14], and other expert bodies [15–17] have also endorsed policy and practice recommendations for physical activity in childcare settings. The implementation of physical activity "best practices" is weak in the state of Florida. In the *Prevention Status Report 2013* [13], Florida received the lowest rating (27.7% of the 47 recommended components of nutrition and physical activity) in the inclusion of nutrition and physical activity standards in state regulations of licensed childcare facilities.

While there is a growing body of research related to the physical activity needs of preschool children [18–21], there is a void in the literature related to evidence-based interventions that address known barriers to successful implementation of classroom-based interventions for preschools [22–24], including specific training for childcare providers on physical activity curricula, using resources that are easily accessible to childcare providers and free of charge and reinforce learning objectives and easily adapted strategies that are directly integrated into ongoing preschool classroom activities. The aim of the present study was to describe the formative process used in developing a physical activity training curriculum for childcare providers to implement in a childcare setting. This included an evidence scan for evidence-based best practices related to physical activity initiatives in childcare centers, comprehensive assessment of training needs of local childcare providers using focus groups and key informant interviews, and environmental self-assessment of physcial activity in childcare setting. These data sources contributed to the development of the childcare provider training workshop and physical activity curriculum resources. The University of West Florida's Institutional Review Board reviewed and approved this study.

2. Methods

2.1. Evidence Scan. A review of the evidence of related materials for childcare centered-focused curricula promoting physical activity was completed in Fall 2014. Programs and studies were identified through a database search that included PubMed/Medline and Google Internet search. The PubMed search, which was not meant to serve as an exhaustive systematic review of the literature, included only articles that had been published in peer-reviewed/academic journals. The Google search included websites and linked toolkits, reports, and flyers. Search terms related to the population of interest included *preschool* and *child care* or *childcare*. Search terms related to the outcomes of interest included *program*, *curriculum*, *physical activity*, *active living*, *sedentary behavior*, *movement*, *screen time*, *locomotor*, *play*, and *gross motor*; combinations of these search terms were used to search the databases (e.g., preschool AND program AND physical activity).

For the PubMed/Medline search, titles and abstracts were reviewed to determine whether the abstract or full reference met the search criteria listed below. Abstracts selected for further review were identified and evaluated to determine whether review of the full article would occur. Selected full papers, including several previously published systematic reviews of the literature, were reviewed to make a final determination of whether the studies/programs would be recommended for potential use. For each Google search, hit titles were reviewed to determine whether they met the search criteria. Due to a large number of Google hits, they were only reviewed through page five of the Google searches. Hits from unreliable sources, such as personal blogs, were excluded.

Any study/program designs were eligible for inclusion in this review including international studies. Inclusion criteria also covered studies/programs that focused on children of ages five and under and on increasing physical activity and/or reducing sedentary behavior. We also included programs focused on other outcomes (e.g. nutrition) if they described a separate physical activity curriculum. Studies/programs that focused on kindergarten students 5 years or older were excluded. We excluded studies/programs that provided no information regarding how the activities linked to early childhood learning objectives and studies/programs that did not provide a full physical activity curriculum available online free of charge or free via a request from the creators at no charge. A full curriculum was defined as including all physical activity program materials and instructions/guidelines for instructors. Because of noted funding constraints by early childhood education teachers, popular programs that were only available for a cost (e.g., SPARK, CATCH Early Childhood) were not included.

2.2. Key Informant and Focus Group Interviews. Participants in key informant and focus group interviews were recruited through the Early Learning Coalition (ELC) in Northwest Florida, whose purpose is to support children and families for lifetime success by preparing children to enter school ready to learn and helping families achieve economic self-sufficiency. Purposeful sampling techniques were used to identify childcare directors, staff, and teachers to participate in discussions. Key informants included childcare center directors ($n = 34$). Focus group participants were staff and teachers from childcare centers and home-based providers ($n = 14$) and

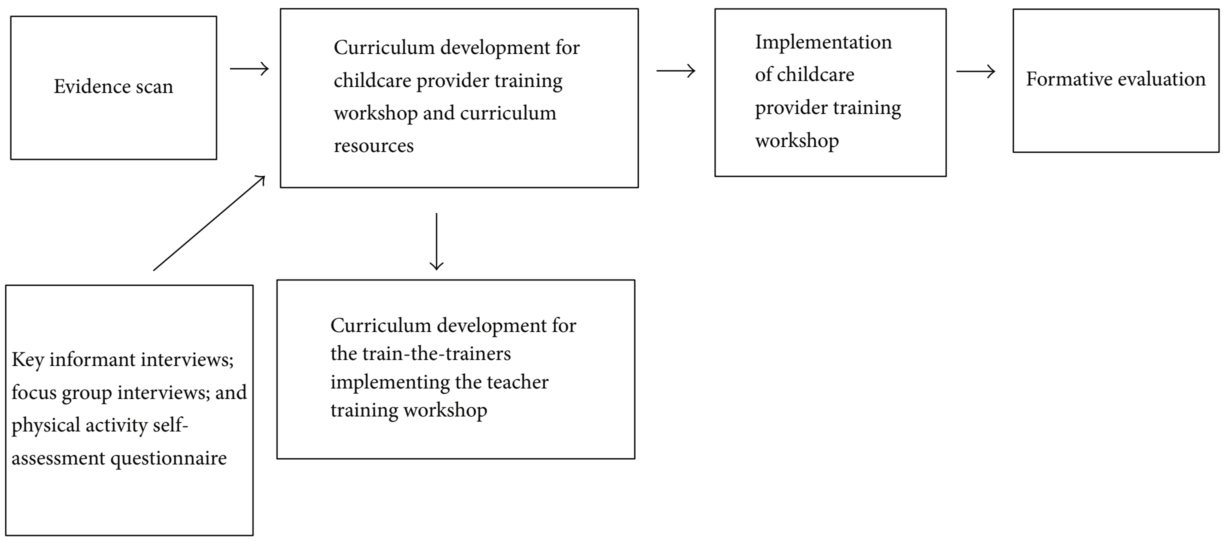

Figure 1: Flow diagram for curriculum development.

staff from the ELC ($n = 6$). Before being interviewed, the participants completed an informed consent form and a demographic questionnaire. Trained interviewers, using a standard questionnaire guide that included probing questions to elicit additional information as needed, conducted interviews. All interviews and focus groups were digitally recorded.

An initial round of key informant and focus group interviews took place in December 2014. Questions were developed based on the results of the evidence scan. Questions assessed typical daily routines in the childcare setting for children and staff, how lessons are typically taught, staff perceptions of the importance of teaching children about nutrition and physical activity, perceptions of how staff behaviors influence children's behaviors, and suggestions from teachers about the format of a training program and training materials for teachers and student curriculum content. A trained project team member reviewed each recording, summarized question responses, and noted general themes. Themes from the entire document were reviewed as a whole to determine similarities or contradictions across responses. Two additional project team members reviewed the recordings and summaries and provided input regarding agreement with themes. Discussion occurred until final agreement on themes and implications was reached within the team. Implications and themes were incorporated into teacher training materials and the student curriculum.

2.3. Physical Activity Environmental Self-Assessment Questionnaire. A representative from each center that participated in the interviews or focus groups completed a self-assessment questionnaire to assess environments and policies related to physical activity at their respective childcare center. The questionnaire was selected by the local health department since it was a part of Maine's *5-2-1-0 Goes to Child Care* program and adapted from the *Nutrition and Physical Activity Self-Assessment for Child Care* (NAP SACC) [25] and *Let's Move! Child Care* [26]. The questionnaire assessed general center characteristics, play time and sitting policies, existing training opportunities for physical activity, availability of indoor and outdoor space and equipment for physical activity and play, screen time policies, and staff wellness policies. Frequencies and percentages were used to tabulate responses to each question included in the self-assessment. Implications were also noted based on findings from the survey and incorporated into the teacher training curriculum.

2.4. Curriculum Development. Findings from the evidence scan, key informant and focus group interviews, and the physical activity self-assessment were used to create a draft set of teacher workshop topics, training overview, and training materials to be provided to teachers (Figure 1). A second round of follow-up key informant and focus group interviews occurred in March 2015 to solicit feedback from childcare providers about the proposed training format and materials. Questions assessed how and where training sessions would be offered, length and format of training, training session content, and suggested posttraining technical assistance. Feedback was incorporated into the development of the final teacher training workshop curriculum and materials.

2.5. Pilot Teacher Training Workshop. The pilot teacher training workshop, *Let's Wiggle with 5-2-1-0: Promoting Physical Activity in Early Learning Settings*, took place in April 2015 at a childcare center's afterschool classroom. The teacher training workshop was offered on a Saturday morning since that was the preferred time recommended in key informant and focus group interviews. Sixteen of the 18 (89%) childcare providers recruited by the ELC attended the training workshop.

3. Results

3.1. Evidence Scan. From the 2,058 records identified in PubMed, only 23 matched the search criteria and warranted a review of the full articles. Upon further inspection, only

Table 1: Low-cost physical activity curricula accessible through the Internet.

Curricula	Sponsoring agency	URL
Go smart	National Head Start Association	https://gosmart.nhsa.org/
Hop™ family resource*	Decoda Literacy Solutions, British Columbia	http://activeforlife.com/hop-resource/
Keystone kids go active	Pennsylvania Department of Human Services, PA Nutrition Education Network	http://www.panen.org/keystone-kids-go/go-active
Move™ family resource*	Decoda Literacy Solutions, British Columbia	http://www.decoda.ca/resources/online-resources/resources-child-family-literacy/leap-bc/move/
Sesame street we have the moves: physical activity resource	US Department of Health & Human Services and the National Association for Family Child Care	http://www.sesamestreet.org/cms_services/services?action=download&uid=46841dfe-a76c-4df7-8e40-d165417d9be5

*The HOP and MOVE programs are the same program for different age groups. MOVE is for ages 0–3 and HOP is for ages 3–5.

one of the 23 articles reported on a program that focused on preschool children, included a full physical activity curriculum free of charge and available online, and reinforced learning objectives in the classroom. That program had two names: MOVE, for children ages 0–3 years, and HOP for children ages 3–5 years. From the 218,788,900 hits on Google, only 13 hits from the first five pages matched the search criteria and warranted a full review of the program. After further review, only three programs met the final search criteria and were recommended. A total of four programs met the inclusion/exclusion criteria for the evidence scan (Table 1). Each of these programs contained a pool of activities intended to promote physical activity and support growth and development in children of ages 0–4 and incorporated or reinforced early childhood learning objectives. These activities were incorporated into the curriculum resources used in the teacher training workshop.

3.2. Key Informant Interviews and Focus Group Interviews. A total of 54 childcare staff participated in the initial key informant and focus group interviews in December 2014. This represents a convenience sample of referrals identified by the ELC. Participant demographics are included in Table 2; participants were representative of the local target population of childcare providers. Themes and implications that emerged from the initial round of interviews and focus groups indicated that childcare providers work fairly long shifts because of parent schedules. The busiest times of day are early mornings, during drop-off and transition periods between activities; nap time is the least stressful time of day. All respondents agreed that teaching health behaviors to children was important and that children tended to watch and mimic staff behaviors, highlighting the importance of staff also demonstrating healthy behaviors in addition to teaching curriculum content. Staff highlighted three preschool educational curricula that were typically used to plan lessons and cited ease of use, availability of hands on and colorful materials, and materials that incorporated existing early learning standards as keys to a useful curriculum. Staff indicated interest in participating in training to incorporate physical activity into classroom settings, particularly if training was offered on the weekends, included written materials, and helped to fulfill requirements for continuing education credits necessary to maintain licensure.

Home care providers identified additional specific factors that were not raised by center staff including the wide age ranges of children at home care facilities since they provide before and after school care, as well as birth to age five child care, and the need for activities that can be adapted for a wide range of ages. Home care staff were frequently cited as being considered “extended family” for children and families, often providing basic lessons on child rearing, cooking, and homemaking for younger parents. Home center providers also cautioned against providing physical activities that required extensive space or equipment, since space is limited in home-based centers.

In March 2015, 18 individuals participated in the follow-up key informant and focus group interviews to review and provide feedback on the planned training curriculum and student intervention materials and to offer additional suggestions (see demographics in Table 2). In general, respondents were pleased with the curriculum materials that were developed and felt that their initial suggestions had been incorporated. Teachers requested additional activities that incorporated music and movement, more transition activities given that transitioning between activities was often difficult, and limiting activities requiring equipment or only including activities with minimal equipment that can be gathered quickly. Childcare providers wanted flexible activities that had guidelines but that were not “too structured.” Home center staff again highlighted the importance of activities that can be implemented with a wide range of ages.

Respondents suggested a two- to three-hour training time frame and preferred training that included staff from other childcare centers so new perspectives and ideas could be shared. The consensus was that Saturday was the best day for a long training, particularly since parents were often late picking children up at the end of the day and after clean up and

Table 2: Demographic characteristics of key informant and focus group participants.

	December 2014 ($N = 54$)	March 2015 ($N = 18$)
Years in childcare	*N (%)*	*N (%)*
0–5 years (entry level)	8 (14.8)	4 (22.2)
>5–10 years (mid-career)	9 (16.7)	0
>10–20 years (experienced I)	19 (35.2)	6 (33.3)
>20–30 years (experienced II)	14 (25.9)	7 (38.9)
>30 years (late career)	4 (7.4)	1 (5.6)
Childcare facility type		
Family childcare home	20 (37.0)	7 (38.9)
Small center	8 (14.8)	3 (16.7)
Medium center	15 (27.8)	3 (16.7)
Large center	2 (3.7)	0
Coalition	6 (11.1)	4 (22.2)
Missing data	3 (5.6)	1 (5.6)
Years in current program		
<1 year	3 (5.6)	1 (5.6)
1 to <2 years	2 (3.7)	2 (11.1)
2 to <5 years	15 (27.8)	6 (33.6)
5 to <10 years	13 (24.1)	1 (5.6)
10 to <15 years	12 (22.2)	3 (16.7)
15 to <20 years	3 (5.6)	3 (16.7)
20 years or more	5 (9.3)	2 (11.1)
Missing data	1 (1.9)	
Current job position		
Owner	23 (42.6)	8 (44.4)
Director	17 (31.5)	3 (16.7)
Teacher	10 (18.5)	1 (5.6)
Assistant director	1 (1.9)	2 (11.1)
Provider assessment and training	3 (5.6)	4 (22.2)
Level of education		
High school graduate	15 (27.8)	5 (27.8)
GED	2 (3.7)	0
Some post-high school education	7 (13.0)	1 (5.6)
Associate degree	11 (20.4)	3 (16.7)
BA or BS degree	8 (14.8)	6 (33.3)
Post BA or BS degree	5 (9.3)	2 (11.1)
Certificate program	5 (9.3)	1 (5.6)
Other	1 (1.9)	0
Age		
21 to 29 years	7 (13.0)	1 (5.6)
30 to 39 years	9 (16.7)	2 (11.1)
40 to 49 years	15 (27.8)	4 (22.2)
50 to 59 years	17 (31.5)	6 (33.3)
60 years or older	4 (7.4)	4 (22.2)
Missing data	2 (3.7)	1 (5.6)

Table 2: Continued.

	December 2014 ($N = 54$)	March 2015 ($N = 18$)
Gender		
Male	2 (3.7)	1 (5.6)
Female	50 (92.6)	16 (88.9)
Missing data	2 (3.7)	1 (5.6)
Ethnicity		
African American/black	32 (59.3)	9 (50.0)
Asian American/Pacific Islander	1 (1.9)	0
Caucasian/white	17 (31.5)	6 (33.3)
Native American	0	2 (11.1)
Hispanic/Latino	2 (3.7)	0
Missing data	2 (3.7)	1 (5.6)

closing a center, attending a weekday evening training would be challenging. Respondents were highly supportive of having continuing education credits and felt that would impact their willingness to attend training. Overall, respondents felt it would be important for researchers to reach out several times following the training to be sure the student curriculum was being used and to assess further support if needed.

ELC staff participated in a specific focus group for their team and provided suggestions for the teacher training materials and student intervention curriculum based on their previous experiences with providing training for early childcare educators. They suggested providing teachers with 50 to 250 activity cards, preferably laminated for durability and made easily available to teachers. ELC staff volunteered to review activity cards to assist researchers with matching activities to early learning standards. ELC staff also supported the idea of providing some equipment for implementing activities during teacher training, with additional equipment provided at technical assistance visits following training, once it was clear that childcare staff were implementing lessons learned during training. All of the recommendations from the childcare providers and ELC staff were incorporated into the final teacher training workshop curriculum.

3.3. Physical Activity Environmental Self-Assessment Questionnaire. Twenty-two directors from childcare centers completed the physical activity self-assessment questionnaire. All of these centers reported serving children of ages one to five years with 77% also providing care for children under one and 95% also caring for children five years and older. Ninety-five percent of the centers were full day programs and most centers offered Florida's Voluntary Prekindergarten (VPK) program. Additionally, 91% of programs required continuing education (CE) for certification or licensure; however, only 27% of the centers offered CE.

With regard to physical activity, 77% of the centers provide active play for more than 45 minutes daily, and all centers reported providing outdoor active play time with 54% of the centers reporting one or more times for a total of 30–45 minutes. Only six centers (27%) reported two or more play times daily with a total outdoor activity time of 60 minutes or more. Most centers reported that children were expected to be seated for long periods of time. For example, 64% reported this expectation for more than 30 minutes at a time or 15–30 minutes on three or more occasions. Ninety-one percent of the centers stated that active play time is often or sometimes withheld for misbehavior. Finally, respondents indicated limited existing training opportunities for physical activity for childcare providers and parents.

Most (77%) of respondents reported having ample indoor space available to accommodate active play and 73% reported having multiple outdoor play areas and open space for running and/or a path for wheeled toys; however, only 22.7% indicated having sufficient variety of and equipment for multiple children to use at the same time. Most centers (76.2%) reported limiting television/DVD viewing during meals or snack times and reported limiting screen time as a reward for good behavior. Most centers (71.4%) stated that computer time is limited to 15 minutes per day per child and that providers typically watch children during screen time activities. Centers reported that they had not received training on screen time reduction or media literacy for preschool children for staff and/or parents. Fifty-nine percent of directors stated that their center had not participated in programs supporting healthy eating and active living within the past year. Only 14% of center directors reported having programs that support healthy eating and active living. Twenty-one of 22 centers (95%) have policies that require that all children have opportunities for physical activity every day, which is usually enforced. Approximately 91% of the centers had policies that require that recreational screen time be limited for all children, and the policy is usually enforced at the centers.

Summary of physical activity environmental self-assessment completed by child care center directors ($n = 22$) is as follows:

Assessment item is physical activity:

(i) With regard to active play time, 77% of centers provide active play time for more than 45 minutes daily:

  (a) 15 centers (68%) provide 46–90 minutes and 2 (9%) centers provide 91–120 minutes.

  (b) No centers provide more than 120 minutes; 5 centers (23%) provide 45 minutes or less (which could include 0).

(ii) All centers report providing outdoor active play time:

  (a) 12 centers (54%) report 1 or more times for a total of 30–45 minutes.

  (b) Six centers (27%) report 2 or more times daily for a total of 60 minutes or more.

(iii) Most centers reported that children are expected to be seated for long periods of time:

  (a) 14 centers (64%) reported this expectation for more than 30 minutes at a time or 15–30 minutes on 3 or more occasions.

(iv) 20 schools (91%) reported that active play time is often or sometimes withheld for misbehavior.

(v) Current training opportunities for physical activity for preschool children are limited for providers and parents:

  (a) 12 providers (55%) indicated opportunities were provided one time per year or less.

  (b) 15 schools (68%) reported offering such education to parents one time per year or less.

Assessment item is childcare environment:

(i) With regard to indoor gross motor play areas, 17 centers (77%) reported having ample space for some or all active play.

(ii) 16 centers (73%) reported having multiple outdoor play areas and open space for running and/or a track/path for wheeled toys.

(iii) Only 5 centers (22.7%) indicated having sufficient variety and amount of equipment for children to use at the same time.

(iv) Most centers (76.2%) report limiting television/DVD viewing during meals or snack times or as a reward.

(v) Most centers (71.4%) report that computer time is limited to 15 minutes per day per child and is only available during a set time of day.

(vi) Most centers (81%) report that providers are supervising and watching children during screen time activities all or most of the time.

(vii) Center staff report no training on screen time reduction and/or media literacy for preschool children for staff or for parents.

(viii) Within the past year with regard to programs supporting healthy eating/active living,

  (a) 13 centers (59%) participated in no programs,

  (b) 3 centers (14%) reported program-wide programs.

(ix) 16 centers (73%) do not have a staff wellness policy.

(x) 21 centers (95%) have policies that require that all children have opportunities for physical activity every day and the policy is usually enforced in the program, and the director has verified it.

(xi) 20 centers (91%) have policies that require that recreational screen time is limited for all children and the policy is usually enforced in the program, and the director has verified it.

Table 3: Final training workshop topics.

Topic	Timing
Welcome & introductions	10 minutes
5-2-1-0 Let's Go, Escambia!	10 minutes
Physical activity in the early learning setting	10 minutes
Finding and selecting quality activities	10 minutes
Round Robin, trying out a number of activities	40 minutes
How to weave physical activity into your weekly plans	5 minutes
Activity, match early learning standards & activities	15 minutes
Engaging parents	5 minutes
Practicing over the next 4 weeks & CEUs	5 minutes
Q&A	5 minutes
Postquestionnaire	5 minutes

Table 4: Overall course evaluation.

Please rate the quality of the following	Poor (1)	Fair (2)	Good (3)	Very good (4)	Excellent (5)
			Mean		
Overall content of course			4.81		
PowerPoint slides			4.63		
Participant manual			4.63		
Presentation of material by trainers			4.73		
Participant/group activities			4.81		
Facilitation of activities by trainers			4.81		

3.4. Final Teacher Training Workshop Curriculum. As mentioned, the evidence scan, key informant and focus group interviews, and physical activity environmental self-assessments were used to create the final two-hour teacher training workshop curriculum. Workshop topics and timing are listed in Table 3. Workshop attendees had opportunities for hands-on engagement throughout the workshop, including practicing the suggesed classroom-based activities (e.g., parachute games, transition activities using bean bags and poly spots, cooperative activities that provided opportunities for physical activity, and encouraged teamwork and problem solving) and identifying how activities satisfied early childhood learning standards. Participants received copies of the workshop PowerPoint presentation, several handouts with resources related to childhood obesity, and brochures for the ongoing *5-2-1-0 Let's Go!* campaign related to general information, physical activity, and screen time. Each teacher recevied a set of 20 *Physical Activity Curriculum Cards* (PACC) and resource materials. Every center that attended the training received *5-2-1-0 Let's Go!* parent education brochures, physical activity posters, and a *Physcial Activity Toolkit* that contained an additional 160 PACC, balls, bean bags, polyspots, scarves, parachute, hoola hoops, and child yoga book. Teachers received 0.2 CEUs for participating in the training.

3.5. Teacher Training Workshop. Research staff delivered the teacher training workshop with support from local university student volunteers. Sixteen (16) staff from six childcare facilities participated in the two-hour training, including 11 full-time (35+ hours per week) and 5 part-time (<35 hours per week) staff. Most attendees were more experienced providers compared to the representative population, with 43.75% having greater than 20 years working in childcare, 25% with 10–20 years of experience, and 31.25% participants under ten years. Six attendees reported working primarily with preschoolers (3–5 years), 3 worked with children ≤2 years, 1 worked primarily with school aged children (≥6 years), and 5 worked with all age groups; 1 attendee did not provide a response to this question. Most centers ($n = 15$) reported that they offered the voluntary pre-Kindergarten (VPK) program at their center, which required a structured curriculum during the morning.

Teacher training workshop participants completed a course summary evaluation following the workshop (Table 4). Scores regarding the quality of the training, materials, and activities were high, ranging within 4.63–4.81 based on a Likert scale that ranged from 1 (poor) to 5 (excellent). Participants also provided a rating of their knowledge and skills before and after the workshop (Table 5). Workshop participants reported increases in knowledge and skill in all areas including knowledge of benefits of physical activity for children, developmental milestones for children, the *5-2-1-0 Let's Go!* campaign, age appropriate physical activities for preschool children, and strategies for adapting activities for the school day and differently abled children. Attendees reported being well prepared to make use of at least two activities learned during the training. Additional requested support included more suggestions and training on how to use activities, frequent check-ins and reminders about how and when to use equipment, posters and flyers, more activities for infants, and concrete suggestions for parent involvement. Teachers also requested additional training on improving nutrition and wanted training delivered directly at individual centers where specific environments could be incorporated into the training.

4. Discussion

There is a void in the literature related to evidence-based interventions involving physical activity and nutrition curricula that focus on preschool children, are easily accessible (e.g., available online), and free of charge and that reinforce learning objectives in the classroom. The current study suggests that childcare providers understand the importance of health-related behaviors in young children and are cognizant of their role in teaching about and demonstrating healthy behaviors for children. When given the opportunity, teachers are willing to learn about strategies for incorporating physical activity into daily classroom activities.

Cost, access, and emphasis on early learning standards are three critical components that increase the likelihood

Table 5: Self-assessment of knowledge and skills.

1 = no knowledge/skills; 3 = some knowledge/skills; 5 = a lot of knowledge/skills	Before-training mean	After-training mean
Benefits of physical activity (PA) for children	3.31	4.75
Developmental milestones for children	3.69	4.69
Makeup of childcare centers in county	3.00	4.19
Day-to-day activities in childcare centers in county	3.38	4.69
5-2-1-0 Let's Go! campaign	2.81	4.75
Age appropriate PA for preschoolers	3.50	4.81
Strategies for incorporating PA in childcare	3.50	4.88
Age appropriate PA adaptation strategies	3.19	4.81
Ability appropriate PA adaptation strategies	3.19	4.75

that materials will be incorporated into standard practices in childcare settings. These findings are based on our insights from childcare providers and the ELC who provided technical assistance for childcare providers and are in line with other studies that have assessed factors that improve intervention fidelity among teachers [22, 24]. Having training and curricula that assist teachers with meeting requirements (e.g., continuing education for licensure and early learning standards for curricula) increases the likelihood of participation and use of materials. The evidence scan identified only a handful of curricula that are free and easily accessible, increasing the potential translatability of the student intervention materials to a wide range of settings, particularly in low-income communities where resources to purchase expensive materials may not be available. Although many publications described developing and testing of preschool interventions, the curricula were not provided. While it is possible to contact study authors to attempt to obtain curricula, it is unlikely that under resourced and busy childcare providers will take the extra steps necessary to do so. A recent review of the literature identified 97 articles describing 71 interventions focused on impacting obesity or related behaviors in 3–5-year-olds in childcare settings [10]. None of the studies identified met the criteria for free and easily accessible programs for our evidence scan. To increase the likelihood that evidence-based best practices for improving health in childcare settings are disseminated and implemented, future research should also include strategies for increasing access to materials for end users.

Participation of and input from childcare leadership and staff in key informant interviews and focus groups was critical for understanding nuances within center childcare environments and the most effective strategies for intervening on children's physical activity in classroom settings. Input from childcare staff was also helpful for understanding how to structure training and the types of intervention materials that would be most likely utilized by childcare staff. Their input changed the researchers' planned materials and activities in ways that enhanced the workshops and training materials (e.g., offering training on Saturday, providing hands-on activities and continuing education, having regular follow-up visits, and providing activities on large laminated cards that are easy to read and clean if spills occurred). In our and other recent reviews of the literature, we did not identify any published studies that described extensive input from childcare staff in developing and shaping training materials and interventions to promote physical activity in childcare settings. A recent paper described protocol fidelity among teachers in an intervention designed to increase physical activity during play time [22]. The authors noted that low teacher fidelity (only 67.2% of teachers implemented the program as instructed) and barriers to implementation (e.g., time) as possible reasons for lack of findings between intervention and control groups and suggested that future studies fully incorporate childcare provider feedback when developing interventions. A separate study evaluating a physical activity and nutrition intervention in Mexican American children reported high fidelity with 72%–98% of teachers completing planned classroom activities and 22%–88% of teachers using classroom activities at least twice weekly [27]. In the Alhassan and Whitt-Glover study [22], teachers were provided with specific instructions and a protocol for when intervention activities should be implemented, which was developed by study researchers. The Yin et al. study [27] also provided a schedule and guide for when teachers were to use the intervention materials; however, the schedule was developed by two center directors and one experienced teacher.

The current study tested the feasibility and acceptability of training teachers to incorporate student intervention curriculum materials in classroom-based activities rather than during outdoor play. Data suggests that the influence of parents/adults has been negatively associated with outdoor physical activity in children [28]. Data also suggests ample opportunities for active play in classroom settings [29], and provision of training opportunities to assist teachers with understanding how to safely and appropriately incorporate physical activity in classrooms is a promising strategy. The workshop implemented in the current study was well attended, suggesting that the delivery method was useful. We did not receive suggestions for alternative strategies for delivering the workshops. Attendees praised the opportunity for interaction and hands-on demonstrations with the activities, which would have been more difficult with one-on-one or online training formats. The high ratings of materials and activities included in the training and reported increases in knowledge and skills following training suggested that the content was acceptable and worthwhile. Teachers, in particular, reported high confidence in their ability to begin using training content immediately after the workshops. Attendees did request opportunities to view videos of successful implementation of strategies. As this was the first training delivered, case study videos were not available; however, this valuable suggestion will be incorporated into future training workshops.

The trainings offered insight about the additional support that may be needed during and following the workshops. Contrary to our expectations teachers wanted more, rather than less, follow-up and check-ins with research staff for advice on how to use the curriculum. Teachers stated that knowing someone would be checking in with them would motivate them to use the curriculum and equipment. Teachers also wanted to begin using the curriculum and materials and then have the opportunity to interact with research staff in case they had questions. As mentioned, teachers also desired additional training on strategies for engaging parents in physical activity with their children and strategies for intervening on nutrition.

There are some limitations for the current study that should be noted. Childcare providers who participated in focus groups and interviews and provided feedback on the teacher training curriculum were invited by the ELC. The ELC does not work with all childcare providers in the county, and providers not served by the ELC could have had different perspectives. It is also possible that providers who volunteered to participate in the discussion groups and in the teacher training were more interested in promoting physical activity than providers who chose not to participate. Finally, data were collected only from childcare providers in Escambia County, Florida, and it is possible that providers in other regions of the country have different insights. The current study also had several strengths including the sample of childcare providers whose demographics were representative of childcare providers in the area. The combination of the evidence scan and discussion groups with childcare providers allowed the project team to create a training curriculum that directly addressed needs and concerns of childcare providers. Additional review of the curriculum by childcare providers prior to pilot testing ensured that teacher's needs were incorporated into the curriculum.

5. Conclusion and Next Steps

Findings from the current study highlight the feasibility and acceptability of working with childcare staff to develop relevant training and materials that can be used to incorporate physical activity into policies, systems, and environments in early childcare settings. Childcare administrators and teachers were engaged in the development of a training curriculum and provided feedback for future training workshops and continuing education opportunities. Next steps include evaluating the implementation of the student curriculum in childcare settings, understanding the protocol implementation fidelity, and assessing the impact of the training on physical activity levels in children. Additionally, more insight is needed on the benefits of individual coaching for childcare teachers to promote sustainability of physical activity within the classroom setting.

Competing Interests

The authors declare that they have no competing interests.

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Research Article

Maternal Feeding Styles and Food Parenting Practices as Predictors of Longitudinal Changes in Weight Status in Hispanic Preschoolers from Low-Income Families

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Objective. The aim was to investigate the influence of feeding styles and food parenting practices on low-income children's weight status over time. *Method*. Participants were 129 Latina parents and their Head Start children participating in a longitudinal study. Children were assessed at baseline (4 to 5 years old) and again eighteen months later. At each time point, parents completed questionnaires and height and weight measures were taken on the child. *Results*. The indulgent feeding style (parent-report at baseline) was associated with increased child BMI z-score eighteen months later compared to other feeding styles. Authoritative, authoritarian, and uninvolved feeding styles were not significantly associated with increased child BMI z-score. Child BMI z-score at Time 1 (strongest) and maternal acculturation were positive predictors of child BMI z-score at Time 2. Maternal use of restriction positively predicted and maternal monitoring negatively predicted Time 2 BMI z-score, but only when accounting for feeding styles. *Conclusion*. This is the first study to investigate the impact of feeding styles on child weight status over time. Results suggest that indulgent feeding predicts later increases in children's weight status. The interplay between feeding styles and food parenting practices in influencing child weight status needs to be further explored.

1. Introduction

Childhood obesity is associated with a host of negative health outcomes [1] resulting in a major public health concern for Americans [2]. It is well appreciated that environmental and behavioral factors contribute to childhood obesity with the immediate family having direct influences on its development [3]. Considerable evidence supports the premise that parents not only shape children's general development but also shape the development of child eating behaviors [4] and their weight status [5]. Studies linking parent-child behavioral processes to child weight have targeted parenting styles and parenting practices as playing a role in either fostering or preventing childhood obesity. *Parenting styles* are considered to be the stable overall attitude that parents have regarding how to socialize their children into becoming productive adults [6, 7]. In contrast, *parenting practices* are more goal oriented directives used to get the child to comply with a specific task [8]. In a recent review article, Shloim and colleagues [9] identified four studies (three longitudinal and one cross-sectional) that showed significant associations between parenting styles and child body mass index (BMI). For example, in one study children of parents with an indulgent parenting style were more likely to become overweight three years later compared to children of parents with an authoritative or authoritarian style [10]. In another study, high levels of protectiveness were associated with higher odds of children being overweight or obese five years later [11]. These longitudinal studies provide compelling evidence supporting the fact that some parenting styles contribute to the development of childhood obesity; however, problems exist in this literature due to inconsistent measurement of parenting and the lack of identification or examination of specific processes or mechanisms within these global parenting styles that either foster or thwart the development of appropriate child eating behaviors that lead to overweight and obesity.

Feeding styles also have been associated with child weight status mostly in cross-sectional studies. Feeding styles use a similar framework to parenting styles but specifically target parents' overall attitudes around the socialization of child eating behaviors [12]. Feeding styles are measured along two dimensions of demandingness and responsiveness specifically in the eating domain [12]. Demandingness refers to the level of demands parents make of their children during eating episodes, while responsiveness refers to how sensitive parents are to their child's individual needs during eating. High and low levels of these two dimensions translate into four feeding styles: authoritative parents (high demandingness/high responsiveness) make reasonable demands of their children while remaining sensitive to their child's needs; authoritarian parents (high demandingness/low responsiveness) are highly controlling and show little sensitivity to the child's needs; indulgent parents (low demandingness/high responsiveness) are sensitive to their child's desires during meals but provide little structure during eating allowing children extensive freedom; and uninvolved parents (low demandingness/low responsiveness) exhibit little control and involvement during eating.

The indulgent feeding style has been associated with higher child weight status across a series of cross-sectional studies with low-income families (see El-Behadli et al., 2015, for a review [13]). The indulgent feeding style has also been associated with child eating including self-selection of larger portion sizes and consumption [14], lower intake of fruit, vegetables, and dairy [15], and higher intake of energy dense foods [16]. Unlike studies linking general parenting styles to child weight status, studies examining feeding styles provide information regarding the specific mechanisms that foster the development of problematic eating behaviors in children. The premise is that parents who are indulgent are highly responsive to their child's eating preferences without setting appropriate limits. This does not help their child learn to pay attention to internal cues of hunger and satiety in our current food culture and instead fosters overeating and excessive intake of low nutrient, high calorie foods, thus contributing to child weight gain [17].

Certain food parenting *practices* have also been shown to be detrimental to the development of appropriate child eating behaviors. This includes restricting children's access to certain foods and pressuring the child to eat [5]. Much of this work has relied on the Child Feeding Questionnaire [18] to measure food parenting practices as it is the most common instrument used in the childhood obesity literature [5, 19]. The Child Feeding Questionnaire (CFQ) measures three food parenting practice constructs: *restriction* described as limiting child access to certain foods, *pressure to eat* described as making sure the child is eating enough, and *monitoring* described as keeping track of the child's intake of snacks and high fat foods. Restriction and pressure to eat are the only two feeding practice constructs that have been consistently associated with child weight status over multiple cross-sectional studies, with restriction positively associated with child weight status and pressure to eat showing a negative association [4, 5, 9, 19]. Data from longitudinal studies are less consistent. Although the Ventura and Birch [4] review found that restriction predicted weight gain in four of the five longitudinal studies they reviewed, Shloim and associates [9], in their review of studies since 2010, found that restriction positively predicted child weight status in only one of the four relevant longitudinal studies they located. Neither of the reviews identified longitudinal prediction of pressure to eat. More longitudinal studies need to be conducted with the CFQ to find some consensus regarding the causal link between these food parenting practices and child BMI—especially studies with more ethnically diverse samples at high risk for childhood obesity.

The overall aim of this study was to investigate the influence of feeding styles and food parenting practices on the weight status of low-income Hispanic preschool children over time. Hispanic families were chosen for this study as this ethnic group has a higher risk for childhood obesity relative to other ethnic groups [20]. Our primary goal was to examine indulgent feeding over time as indulgent feeding has consistently been linked to higher child weight in cross-sectional studies but not in a longitudinal design. An additional goal was to examine food parenting practices over time as previous studies have produced mixed results in associating these constructs to child weight longitudinally. We hypothesized that feeding styles, specifically the indulgent feeding style, would be associated with low-income child weight status over time. We expected that the influence of feeding styles would be beyond that of food parenting practices, because feeding styles assess parent interactions with their child in the context of both child- and parent-centered items. Food parenting practices only examine one construct at a time and do not capture other behaviors that parents exhibit when interacting with the child during meals (i.e., the global pattern of parent-child interactions). To provide the strongest test of the hypothesized associations, we controlled for a number of variables that have been associated with feeding behaviors in immigrant populations [21–25].

2. Methods

2.1. Participants. Participants were one hundred and twenty-nine Latina parents and their children participating in a longitudinal study (all mothers). Parents were recruited from Head Start centers in a large urban city in southeast United States when their child was 4 to 5 years old. One hundred and eighty-seven parents and their children participated at the first time point of the study. Eighteen months later, data from 144 parents and children were collected—129 had data on all of the variables for the present study.

2.2. Procedures. At Time 1, parents and their children came into our study laboratory on two separate days to participate in observational tasks related to self-regulation. On day two, parents completed a set of questionnaires while the child was involved in the tasks. Height and weight measures were taken on the child. All study staff were bilingual and parents were given the opportunity to complete the questionnaires in English or Spanish. About 77% of the parents preferred the Spanish questionnaires. At Time 2 (18 months later), parents and their children completed the same tasks as Time 1 over a two-day period. Height and weight measures were taken on the children. Participants were reimbursed for different aspects of their participation in the study with a possible total of $90 at Time 1 and $185 at Time 2. The study was reviewed and approved by the Institutional Review Board at the Baylor College of Medicine. The purpose of the study was explained to parents in English or Spanish and written consent was obtained before participation. Child verbal assent was secured as well. Parents were told that the purpose of the research was to study the development of children's eating behaviors.

2.3. Measures. All questionnaires used in this study have been translated into Spanish and back-translated into English to assure understanding of the wording and concepts. These questionnaires have been used successfully in previous studies with Hispanic participants [13].

2.3.1. Demographics. Demographic information was obtained including birth dates (parent and child), ethnicity, gender, education, marital status, and immigrant status.

2.3.2. Caregiver's Feeding Styles Questionnaire (CFSQ). The CFSQ was used to assess feeding styles of parents in this study [12]. The CFSQ was designed specifically to assess feeding in low-income, ethnically diverse samples [12]. Seven child-centered and 12 parent-centered feeding directives are used to derive two dimensions of demandingness and responsiveness. Parents respond to the 19 directives on a 5-point Likert scale ranging from *never* to *always*. The dimension of responsiveness assesses promotion of child autonomy (e.g., reasoning, complimenting, and helping the child to eat), while controlling for overall feeding directives. The dimension of demandingness assesses the use of both child- and parent-centered directives. A cross-classification of high and low dimension scores identifies four feeding typologies: authoritative (high responsiveness, high demandingness), authoritarian (low responsiveness, high demandingness), indulgent (high responsiveness, low demandingness), and uninvolved (low responsiveness, low demandingness). Evidence of test-retest reliability, internal consistency, and convergent and predictive validity has been demonstrated [12]. The CFSQ has been validated with observations of parent/child interactions during dinnertime [17]. A more complete discussion of the scoring procedure can be found elsewhere [12].

2.3.3. Child Feeding Questionnaire (CFQ). The CFQ was used to assess food parenting practices in this study [18]. The CFQ measures four attitudes (perceived responsibility, perceived child weight, perceived parent weight, and concern about child weight) and three practices (restriction, pressure to eat, and monitoring). Only those subscales assessing food parenting practices were used in this study. These included restriction (e.g., I intentionally keep some foods out of my child's reach); pressure to eat (e.g., my child should always eat all the food on her plate); and monitoring (e.g., how much do you keep track of the high fat foods that your child eats?). This measure has been used and validated in low-income samples [12, 26].

2.3.4. Children's Eating Behavior Questionnaire (CEBQ). The CEBQ is a 35-item parent-report questionnaire measuring eight dimensions of child eating [27]. The eight dimensions include food responsiveness, emotional overeating, enjoyment of food, desire to drink, satiety responsiveness, slowness in eating, emotional undereating, and food fussiness. The factor structure, test-retest reliability, and internal consistency have been established [27]. The CEBQ has been used successfully in low-income samples [28]. To reduce the number of variables in the analyses, the three subscales related to the self-regulation of caloric intake—food responsiveness (e.g., my child is always asking for food), emotional overeating (e.g., my child eats more when worried), and satiety responsiveness (e.g., my child gets full before his/her meal is finished)—were used in this study as they have been linked to food parenting practices and child weight in Hispanic samples [29, 30].

2.3.5. Bidimensional Acculturation Scale (BAS). The BAS was used in this study to assess parents' acculturation into the US culture [31]. The BAS consists of three subscales: language use (e.g., how often do you speak English?), language proficiency (e.g., how well do you read in English?), and electronic media (e.g., how often do you watch television programs in English?). Four response categories are used for the language use and electronic media items (almost never, sometimes, often, and almost always). Four different response categories are used for the language proficiency items (very poorly, poorly, well, and very well). Per the developers' recommendations, two domains were created from the three subscales—a Spanish domain and an English domain [31]. Only the English domain was used in this study as almost 90% of the participants scored three or above on the response scale of one to four in the Spanish domain resulting in little variability.

2.3.6. Anthropometrics. Height and weight measurements were taken on the child by trained staff members following a standard protocol to determine body mass index [32]. A stadiometer and an electronic self-calibrating digital scale were used to take the measurements. Children wore light clothing and were asked to remove their shoes. Measurements were recorded to the nearest 0.1 cm (height) and 0.1 kg (weight). Two height and weight measures were taken and averaged. Centers for Disease Control and Prevention Reference Standards were used to generate age- and gender-specific BMI z-scores [33]. Children were classified as normal weight (BMI ≤ 85th percentile), overweight (BMI > 85th ≤ 95th percentile), and obese (BMI > 95th percentile).

2.4. Statistical Analyses. Descriptives were run on all variables and examined to determine distributions and bivariate relationships (using Pearson or point-biserial correlation coefficients). The main study questions were tested with a hierarchical regression analysis. The dependent variable was the BMI z-score at the second time point. The independent variables were entered into the analysis in a sequence of blocks. To provide a stronger test of the association between variables, we strategically placed variables in certain blocks. For example, we statistically controlled for child eating behaviors before examining the role of parental behavior. This was done to address the concern that associations between parental feeding styles and food parenting practices may simply be responses to child eating behaviors. Furthermore, because many of the parents in the sample were immigrants to the USA, we controlled for acculturation in our analyses as well, since acculturation is often associated with child weight status and food parenting practices in immigrant samples [21–25].

Therefore, Block 1 included (a) BMI z at the first time point, (b) the demographic variables of child sex and age in months at the first time point, and (c) parental acculturation—English subscale of the acculturation questionnaire and whether the parent was born in the USA (dichotomous predictor). Block 2 included the three CEBQ child eating behavior subscales at the first time point (food responsiveness, emotional overeating, and satiety responsiveness) to control for child eating behaviors. Block 3 included food parenting practices—monitoring, pressure to eat, and restriction from the CFQ. Lastly, Block 4 included parental feeding styles from the CFSQ (one dichotomous predictor for each of three feeding styles—authoritarian, authoritative, and indulgent). For each dichotomous variable, the mother was assigned a "2" if she demonstrated a particular feeding style and a "1" if she did not. Only three feeding styles could be entered simultaneously into the regressions, because adding a fourth style (i.e., uninvolved) would provide no new information (if a mother had a "1" on all three feeding style variables, her style would be uninvolved). Indulgent, authoritarian, and authoritative feeding styles were chosen for entry into the equation because these three styles have most often been associated with child weight status (positively or negatively) in previous studies of general parenting or feeding styles [13]. To examine the relationship between the uninvolved style and weight change, an additional regression was run with the uninvolved style as the only feeding style predictor. All statistics were run using the Statistical Package for the Social Sciences (SPSS, Version 20.0, Chicago, IL). Statistical significance was set at p value < 0.05.

3. Results

3.1. Sample Characteristics. About an equal number of boys and girls participated. Most of the mothers were born outside of the United States, predominantly in Mexico. Fifty-six percent of the mothers were married and seventy-six percent did not work outside of the home. Sixty-three percent of the mothers had a high school education or less. Finally, ninety-seven percent of the children were born in the United States and fifty-one percent were overweight or obese. Sample characteristics are presented in Table 1.

Table 1: Characteristics of the sample at the first time point (n = 129).

Parent sex, female	100.0%
Child sex, female	45.0%
Parent age, mean in years (SD)[a]	32.01 (6.68)[a]
Child age, mean in years (SD)[a]	4.78 (0.46)[a]
Education of parent	
High school diploma or less	62.8%
Some college or more	37.2%
Employment status, currently employed	24.0%
Marital status	
Married	55.8%
Never married	13.2%
Widowed, separated, or divorced	31.0%
Parent immigrant status	
Born in the USA	15.5%
Born in Mexico	64.3%
Born in Central America	20.2%
Child immigrant status	
Born in the USA	97%
Child BMI categories	
Normal (<85th percentile)	48.8%
Overweight (85th to <95th percentile)	21.7%
Obese (≥95th percentile)	29.5%

[a]Standard deviation.

Comparison of the 129 mothers and children whose data were analyzed here and the 58 parents and children in the Time 1 sample whose data were not analyzed for the present paper (either because they dropped out of the study or they had missing data on acculturation) revealed only one significant difference in the variables in Table 1. Mothers in the current study were more likely to have been born outside of the USA (84%) than parents whose data were not analyzed here (66%): $\chi^2(1) = 8.57$, $p < 0.01$.

3.2. Bivariate Correlations. Presented in Table 2 are the correlations between all study variables. BMI z at both time points was positively correlated with indulgent feeding. In contrast, BMI z was negatively correlated with pressure to eat (both time points) and the authoritarian feeding style (Time 2).

3.3. Hierarchical Block Regression. The results of the hierarchical block regression are presented in Table 3. Table 3 displays the standardized regression coefficients (β) and the adjusted squared multiple correlation (adjusted R^2) for each step. In all of the analyses, BMI z at the first time point was positively associated with BMI z at the second time

Table 2: Correlations between study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1) Female	—														
(2) Age in months	0.03	—													
(3) Food responsiveness	−0.31**	−0.01	—												
(4) Emotional overeating	−0.22*	0.08	0.62**	—											
(5) Satiety responsiveness	0.10	0.11	−0.35**	−0.04	—										
(6) Acculturation	0.04	0.10	−0.03	−0.05	0.08	—									
(7) Born in USA	0.09	0.04	−0.08	−0.09	0.13	0.59**	—								
(8) Monitoring	0.08	−0.04	−0.08	−0.11	−0.02	0.10	0.08	—							
(9) Pressure to eat	−0.18*	−0.12	0.07	−0.14	−0.05	−0.26**	−0.31**	0.09	—						
(10) Restriction	−0.08	0.05	0.17*	0.18*	0.05	−0.20*	−0.34**	0.04	0.30**	—					
(11) Authoritarian	0.02	0.11	0.01	0.14	0.23**	−0.18*	−0.21*	−0.18*	0.26**	0.34**	—				
(12) Indulgent	0.09	0.03	0.01	−0.20*	−0.15*	0.21*	0.26**	0.07	−0.14	−0.42**	−0.54**	—			
(13) Authoritative	0.00	−0.05	0.11	0.14	−0.09	0.08	−0.02	0.13	−0.12	0.01	−0.36**	−0.31**	—		
(14) BMI z (Time 1)	−0.05	0.14	0.14	0.06	−0.20*	0.07	0.01	−0.03	−0.21*	−0.06	−0.16	0.17*	0.02	—	
(15) BMI z (Time 2)	−0.04	0.14	0.13	0.06	−0.15	0.16	0.06	−0.06	−0.20*	−0.04	−0.22*	0.24**	0.03	0.92**	—

$^{*}p < 0.05$; $^{**}p < 0.01$.

Table 3: Regression analysis predicting child BMI z at Time 2 (N = 129).

	Block 1	Block 2	Block 3	Block 4
Model adjusted R^2	0.859	0.857	0.857	0.867
F (model)	$F(5, 123) = 157.288^{***}$	$F(8, 120) = 96.818^{***}$	$F(11, 117) = 70.649^{***}$	$F(14, 144) = 60.523^{***}$
F (R^2 change)		$F(3, 120) = 0.328$	$F(3, 117) = 0.982$	$F(3, 114) = 3.930^{**}$
Independent variables	Std beta	Std beta	Std beta	Std beta
Child sex (ref group: male)	0.008	0.011	0.018	0.012
Child age in months	0.001	−0.004	−0.006	−0.005
Child BMI z (Time 1)	**0.919*****	**0.924*****	**0.929*****	**0.915*****
Acculturation (English domain)	**0.103***	**0.102***	**0.108***	**0.094***
Born in USA	0.013	0.015	−0.003	0.003
Food responsiveness		0.016	0.004	−0.027
Emotional overeating		0.006	0.007	0.038
Satiety responsiveness		0.034	0.026	0.044
Monitoring			−0.048	**−0.068***
Pressure to eat			0.021	0.038
Restriction			0.034	**0.082***
Authoritarian[a]				−0.033
Authoritative[a]				0.050
Indulgent[a]				**0.114***

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.
Std beta: standardized beta coefficient.
[a]For each feeding style variable, a dichotomous predictor was used with a "2" assigned to mothers who showed that feeding style and a "1" to those who did not.

point and was the strongest predictor (standardized β ranged from 0.915 to 0.929, $p < 0.001$). This was followed by the English subscale of the acculturation questionnaire which was positively related with BMI z (standardized β ranged from 0.094 to 0.108, $p < 0.05$) across all four steps. After Step 3 (addition of food parenting practices), the R^2 change was not significant with adjusted $R^2 = 0.857$ and $F(11, 117) = 70.649$. With all 14 independent variables included in the model (Step 4), adjusted $R^2 = 0.867$, $F(14, 114) = 60.523$, R^2 change of 0.010 satisfied F change $(3, 114) = 3.93$, and $p < 0.01$, indicating the addition of the feeding styles from the CFSQ significantly improved R^2. In addition to BMI z at Time 1 and English acculturation, food parenting practices of monitoring ($\beta = -0.068$, $p = 0.046$) and restriction ($\beta = 0.082$, $p = 0.04$) and the indulgent feeding style ($\beta = 0.114$, $p = 0.045$) were significant predictors of BMI z at Time 2 in the full model (Block 4). Restriction and indulgent feeding style were positive predictors of BMI z at Time 2; monitoring was a negative predictor. A separate model with the uninvolved style as the only feeding style predictor (including all of the other predictors) showed no significant effect for uninvolved feeding style: $\beta = -0.02$, $p = 0.52$.

4. Discussion

This study is the first to investigate the impact of feeding styles on children's weight status over time and did so among a sample of low-income Hispanic children from Head Start programs. In support of the hypothesis, indulgent feeding style assessed when the child was an average of 4.8 years old and was associated with increased BMI z-score 18 months later. Authoritative, authoritarian, and uninvolved feeding styles were not associated with changes in BMI z-score over time. The relationship of an indulgent feeding style to child BMI z-scores made a significant contribution to explaining increases in the child's BMI z-score over and beyond the child's baseline BMI z-score, demographics, and the child's eating behaviors at 4 years of age. Other significant predictors of time to BMI z-score in the final model were Time 1 child BMI z-score (strongest predictor), parent's level of acculturation, and parent's use of restriction and monitoring food parenting practices. While the former two were risk factors for greater BMI z-score at time two (positive associations), monitoring at time one was protective or negatively associated with the child's BMI z-score over time.

It is noteworthy that it was the indulgent feeding style that was associated with child's BMI z-score over time since the indulgent feeding style has consistently been associated with higher child BMI z-score or percentile in cross-sectional studies assessing the same construct among low-income African American and Hispanic [12, 28, 34], rural African American, Hispanic, and White [35] and recent immigrant samples [36]. The indulgent feeding style results when parents make few demands on their children during feeding and use mostly child-centered feeding directives. This relatively permissive style of feeding does not provide children with the same level of scaffolding, limit setting, and rules seen among parents who use authoritative or authoritarian feeding styles. Previous work among low-income families found that indulgent and uninvolved feeding styles were associated with lower intake of fruit, vegetables, and dairy [15], providing one possible mechanism through which feeding styles impact child weight status over time. However, it is apparent in the analysis presented here that the indulgent feeding style puts children at greater risk for excessive weight gain over time. This suggests that other mechanisms are also involved. It has been hypothesized that parents who are indulgent may use food to show love and affection for their child, which may contribute to greater energy intake and be an additional mechanism by which indulgent feeding styles contribute to children's excess weight gain [34]. Moreover, the indulgent feeding style may interfere with children's self-regulation of caloric intake because low levels of parental limit setting and use of rules may lead to children overeating and ignoring their internal satiety cues [17]. One strength of the feeding style construct is that it assesses parenting influences on child eating in context of both child- and parent-centered directives, giving a more global assessment of how parents interact with their child during meals compared to food parenting practices.

In this study, the positive association of restrictive food parenting practices and the negative association of monitoring food parenting practices only contributed to the child's BMI z-score at Time 2, when also controlling for the feeding styles. It is possible that food parenting practices are expressed differently among different feeding styles, and therefore both need to be considered when assessing children's weight gain over time. In fact, restriction and monitoring have had more mixed results in studies assessing their association with children's weight or BMI, as compared to feeding styles [9]. Most of the cross-sectional studies have supported a positive association with restriction and child BMI, but longitudinal findings have been equivocal [4, 9]. Monitoring, on the other hand, has generally not been linked with child BMI in cross-sectional nor longitudinal studies [9] but was linked to better dietary quality two years later [37]. One small study previously associated monitoring at age 5 with reduced child BMI z-score at age 7 among low obesity risk children, but not high obesity risk children, as determined by the parent's weight status [38]. Therefore, researchers and health care providers need to take both food parenting practices and feeding styles of parents into consideration when intervening and treating childhood obesity.

It has been argued that much of the association of feeding styles and feeding practices with children's weight status is due to the parenting behaviors being in response to their child's eating behaviors, which may actually drive the association [39]. In the analysis presented here, three child eating behavior characteristics (food responsiveness, emotional overeating, and satiety responsiveness) previously linked to either parent food parenting practices or child weight status in cross-sectional studies [29, 30] were assessed. While satiety responsiveness was significantly negatively correlated with the child's BMI z-score at Time 1, none of these child eating behaviors correlated with the BMI z-score at Time 2. Nor did any contribute to changes in the child's BMI z-score over time when controlling for demographics and acculturation or when considering feeding styles and food parenting practices.

Acculturation, or how much an immigrant adapts to the new culture in which they reside, has been positively associated with the risk of childhood obesity [21–23, 25]. We have previously shown that the level of acculturation of Hispanic parents from this sample at baseline was associated with lower use of restrictive practices, while parents born in the USA were more likely to report an indulgent feeding style and less likely to report an authoritarian feeding style [24]. Here we demonstrate that the parent's level of acculturation to the English/American culture as assessed by English language usage, English language proficiency, and use of English media was predictive of increased child BMI z-score over time. These results are consistent with other studies showing that more acculturated Hispanics tend to have higher levels of obesity than recent immigrants [21, 25], possibly a result of greater exposure to the obesogenic environment in the USA [40, 41].

The limitations of this study should be acknowledged. This study included a convenience sample of Hispanic Americans in one city in southwestern USA and may not generalize to others. The sample size is relatively small, and we did not have complete data on all participants that started the study. However, the only demographic difference between those that provided baseline data and those that completed the study was parental birthplace. The feeding styles and food parenting practices were assessed by self-report. Self-report instruments are more likely than other objective assessments of parenting (e.g., observations) to have errors introduced, such as social desirability biases and biases associated with self-awareness. However, the CFSQ has been validated by observations in the home, providing support that this self-report instrument is capturing important differences in how a parent interacts with their child during a family meal in their home [17]. In addition, we used the feeding style and food parenting practice instruments that have most commonly been used in studies linking parenting to child BMI [5, 19], which allows for better comparison across studies. Finally, we used a p value of $p < 0.05$ and did not correct for Type I error. Given the large number of parameters in the final regression for the number of participants, it is important to replicate these findings in future research.

5. Conclusion

An indulgent feeding style was linked with increases in children's BMI z-score from 4.8 years of age to 18 months later, providing additional support of the importance of feeding styles in influencing child weight status. By controlling for the child's eating behaviors at baseline, we provide support that feeding styles influence child eating behavior and are not just a covariate in reaction to the child's eating behavior characteristics which impact weight. Our results suggest that there may be interplay between food parenting practices and feeding styles in influencing the child's weight status over time. This needs to be investigated further.

Disclosure

The contents of this paper do not necessarily reflect the views or policies of the USDA or mention trade names, commercial products, or organizations that imply endorsement from the US government.

Competing Interests

The authors declare that there are no competing interests regarding the publication of this paper.

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Clinical Study

A Pilot Study of Parent Mentors for Early Childhood Obesity

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Objective. To assess the feasibility of a parent mentor model of intervention for early childhood obesity using positive deviance-based methods to inform the intervention. *Methods.* In this pilot, randomized clinical trial, parent-child dyads (age: 2–5) with children whose body mass index (BMI) was ≥95th percentile were randomized to parent mentor intervention or community health worker comparison. The child's height and weight were measured at baseline, after the six-month intervention, and six months after the intervention. Feasibility outcomes were recruitment, participation, and retention. The primary clinical outcome was BMI z-score change. *Results.* Sixty participants were enrolled, and forty-eight completed the six-month intervention. At baseline, the BMI z-score in the parent mentor group was 2.63 (SD = 0.65) and in the community health worker group it was 2.61 (SD = 0.89). For change in BMI z-score over time, there was no difference by randomization group at the end of the intervention: −0.02 (95% CI: −0.26, 0.22). At the end of the intervention, the BMI z-score for the parent mentor group was 2.48 (SD = 0.58) and for the community health worker group it was 2.45 (SD = 0.91), both reduced from baseline, $p < 0.001$. *Conclusion.* The model of a parent mentor clinical trial is feasible, and both randomized groups experienced small, sustained effects on adiposity in an obese, Hispanic population.

1. Introduction

The prevalence of obesity in early childhood has shown some signs of decreasing; however, for the Hispanic population, it continues to remain high, estimated at 16.7% for 2–5-year-old Hispanic children in the United States, double that of the general population [1]. There are few effective interventions that have enrolled obese, Hispanic children from this age group [2]. There are also very few prevention studies shown to be effective in Hispanic families [3, 4]. Of the intensive, clinical interventions shown to be effective, a major limitation is the intensity required as this limits the intervention's potential public health scope and brings about challenges of sustainability [5–8].

Peer or parent mentors are an alternative to professional counseling for delivering information and assisting with behavioral change. Parent mentors have been used as an effective intervention model in coaching other parents on their child's diabetes management [9] and in childhood asthma [10]. This model may also be an attractive option for the treatment of early childhood obesity because it requires a relatively low amount of resources to initiate a parent mentoring program, and there is potential for empowerment and sustainability within the community. The feasibility of a parent mentor model for obesity has not been examined.

Head Start is a government-funded program for low-income families that includes early learning and school readiness, health and development screenings as well as daily meals, and family well-being to strengthen parent-child relationships. One of Head Start's core values is the empowerment of families, and they serve a population at high risk for obesity; therefore, the parent mentor model of intervention meshes well with their structure and operational values. Head Start programs offer services to nearly one million students [11]. The data on obesity interventions in Head Start centers in other locations have yielded variable results.

The positive deviance approach was used as the premise for building the intervention as it is well suited for high-risk populations and family empowerment. Positive deviance is the idea that, even among those most at risk for an adverse outcome, there are some individuals in the community who find a way to succeed, and, by identifying how those individuals or families succeed, one can identify successful strategies and behaviors that utilize local resources and knowledge [12]. This approach was historically used in malnutrition [13] though it has recently been explored in obesity [14–17].

This study was designed to evaluate the feasibility of a clinical trial to test the hypothesis that parent mentors using positive deviance-derived education could be an effective intervention for early childhood obesity in the context of a Head Start program serving a low-income, Hispanic community.

2. Methods

2.1. Study Design. This was a pilot, randomized clinical trial designed to evaluate the feasibility of an intervention using parent mentors trained in positive deviance behaviors to reduce adiposity among obese 2–5-year-old children. We used community health workers providing education as our comparison group. All of the parent-child dyads recruited for the study were actively enrolled in a Head Start program, Neighbors in Need of Services (NINOS Inc.). The full protocol for this trial is described in greater detail elsewhere [18] and is also available by contacting the corresponding author.

2.2. Sample Selection and Recruitment. NINOS Inc. staff identified 139 families with at least one 2–5-year-old obese child from the 16 centers in the geographic area of this study, Cameron County, South Texas. Identified families were contacted by letter and phone to explain the study and determine interest in participating. Eligibility was determined as having a body mass index (BMI) ≥95th percentile for age and gender. Exclusion criteria were intellectual disability, severe development delay, seizure disorder, diabetes, cerebral palsy, any genetic problem, and inability to communicate in either English or Spanish. Sixty parents provided written consent, and they and their child were enrolled in the study. Parent-child dyads were randomized 1 : 1 to intervention or comparison in blocks of six using REDCap [19]. The randomization allocation table was generated by a research assistant and was concealed from the principal investigator and staff. Enrollment and assignment of participants to intervention and comparison arms were carried out by clinical research unit staff. The staff were not blinded to assignment after enrollment. Recruitment occurred between January and February 2015 (4-week period).

2.3. Parent Mentor Recruitment and Training. Parent mentors were recruited from Cameron County Head Start centers and trained as described previously [18]. Briefly, these individuals were required to have a 2–5-year-old child at a healthy weight who was enrolled in Head Start at the time; the parents themselves could be of any weight. Their education varied from some high school to some college. They were selected by the Head Start staff for their leadership qualities. Four parents received a one-day intensive training on the content of the parent mentor manual and on reflective listening, with three parents selected for participation based on their engagement in the training. The parent mentor manual was developed using the American Academy of Pediatrics guidelines on obesity prevention [20] and the previous study on identified positive deviance practices done in Cameron County [16]. There were five main foci that the parent mentors were instructed on as being potentially effective strategies to share with their parent mentees: dealing with behavior problems without using food, identifying internal motivators for healthy habits, organizational strategies for feeding, accurate perceptions of weight, and effective snacking strategies. They completed worksheets monthly for each encounter with their mentee and reported what topics were discussed. They were compensated for their time with $50 per parent per month.

2.4. Intervention. Parent-child dyads randomized to the intervention arm were assigned to one of three parent mentors. Home assessments with the parent and child were conducted by each parent mentor at baseline and three months after enrollment. A standardized approach to the visit included asking about five main areas (positive deviance behaviors listed above), and then the parent mentors provided coaching on those areas. At least one phone call per month was made by each parent mentor in order to reinforce those behaviors. Intervention parents also participated in community meetings held at Head Start centers. Meetings were conducted on a monthly basis by parent mentors, and each mentor was allowed to implement her own curriculum in accordance with the goals discussed with the participating group. The community meetings for intervention and comparison participants were separately scheduled and located.

2.4.1. Comparison Condition. Parent-child dyads randomized to the community health worker comparison arm had the opportunity to attend one of three monthly community meetings held at Head Start centers. These meetings were conducted by a local *"promotora"* or community health care worker. In contrast to the intervention arm meetings, the comparison arm meetings followed a structured setting outlined by the EatPlayGrow™ Curriculum [21]. Topics discussed during the meetings included health benefits of fruits and vegetables, limiting unhealthy foods, physical activity, portion control, and sleep, using an interactive format via songs, exercise, story time, and snacks. During the hour-long meeting, the first ten minutes were reserved for signing in and serving fruits and vegetables, the following forty-five minutes were for content delivery, and the final five minutes were used to remind parents of the following meeting and discuss any questions. Every parent kept a journal to log thoughts and perceptions about each meeting. Homework handouts were administered to the parents and children. Children were allowed to attend the meetings with their parents but it was not a requirement. In contrast to the intervention arm, parent-child dyads did not receive any home visits or follow-up phone calls throughout the study. The only contact time between the community health worker and parents was during the hour-long community meeting once a month.

2.4.2. Control Group. An interim analysis showed no difference between the two comparison arms of the study. Therefore, a control group was identified with no intervention other than usual care in Head Start which consists of providing healthy meals and messaging on healthy habits in newsletters. Head Start staff weigh and measure each child at enrollment and every six months. The control group children were identified as obese (≥95th BMI percentile for age and gender), were enrolled in Head Start over the same period of time, attended the same local Head Start centers, and were matched to each study participant by sex and on their initial BMI z-score (within 0.3 units). The average baseline BMI z-score difference between participants in the trial and community control group children was 0.03 units.

2.4.3. Outcome Measures. All measures described below were administered in either English or Spanish depending on the preference of the individual participant. The primary outcome was BMI z-score change at the end of the six-month intervention; BMI z-scores were calculated using Centers for Disease Control standards [22]. A postintervention follow-up was completed at 12 months from initial enrollment (six months after intervention). Children were measured and weighed without shoes and in light clothes by trained research staff. Secondary outcome measures assessed at baseline, at the end of intervention (six months), and six months after intervention (12 months from baseline) included health-related quality of life using the Pediatric Quality of Life Inventory (PedsQL 4.0, Mapi Research Trust, Lyon, France) [23], feeding behaviors measured by the Comprehensive Feeding Practices Questionnaire (CFPQ) [24], dietary intake assessed using the Block Kids Food Screener (BKFS) developed by NutritionQuest (Berkeley, CA, USA) [25], screen time, sleep, and outside play using standardized questions previously described [18, 26–28]. Growth (height) velocity was calculated over a twelve-month period, and each individual was plotted on a sex specific growth velocity chart [29].

2.4.4. Feasibility Outcomes. We focused on recruitment, retention, and participation outcomes for our feasibility assessment. Recruitment was evaluated by assessing how many parent-child dyads were screened and contacted to achieve one dyad enrolled. Retention was assessed as the proportion of subjects completing the final study visit. Participation was calculated using a point system for each potential interaction in each arm of the study with fourteen possible points in the intervention arm and six points possible for the comparison arm. These points were categorized into high participation ≥ 65%, some participation ≥ 1% and < 65%, and no participation = 0%.

2.5. Statistical Analysis. The primary clinical outcome of BMI z-score was analyzed under the intention-to-treat principle. Linear mixed models with a random intercept were used to evaluate the primary outcome using randomization group, time (0, 6, and 12 months coded as intervals rather than a continuous variable to evaluate period effects), and their interaction (group × time) as main effects adjusted for baseline measurements; an interaction term between baseline measurement and time was included if significant to account for the intercept variation. This modeling approach was also used for the secondary outcomes of the PedsQL 4.0 scales, CFPQ scales, and diet and activity measures. Data were analyzed using SPSS (version 23; IBM SPSS Statistics, IBM Corporation, Chicago, IL).

2.5.1. Sample Size and Power. Weight maintenance in this age group with continued growth in height leads to a decrease in BMI z-score among obese children of about 0.5 units over 6 months; this approximates a moderate effect size. With an expected mean BMI z-score of 2.5 at baseline, a standard deviation of 0.5, and a two-sided α of 0.05, 30 participants in each group provided 48% power to detect a difference of moderate effect size, 86% power to detect a large effect size (reduction in BMI z-score of 0.8), and 12% power to detect a small effect size (reduction in BMI z-score of at least 0.2).

2.6. Ethics. This study was approved by the University of Texas Health Science Center at San Antonio Institutional Review Board. Both parent mentors and parents of obese children provided written informed consent to participate. This trial is registered at clinicaltrials.gov under NCT02373670. All parents were provided with participation stipends as previously described [18].

3. Results

The total program enrollment for the Cameron County Head Start includes more than 2,700 students. From this cohort of students, 139 families were assessed for eligibility to participate in the randomized clinical trial. Ultimately, 79 families were excluded and 60 were enrolled in the trial. Of the sixty parent-child dyads initially enrolled in the study, forty-eight completed the six-month follow-up visit (end of intervention) (80%) and forty-one completed the twelve-month visit (six months after intervention) (68.3%) (Figure 1). Participation in both the intervention and the comparison groups overall was high, with 76% of all participants meeting the benchmark of ≥65% of possible interactions to qualify as having high participation. Only two of the parent-child dyads had no participation recorded while still completing all study visits for measurements, both in the comparison arm of the study. In assessing adherence, the parent mentors followed

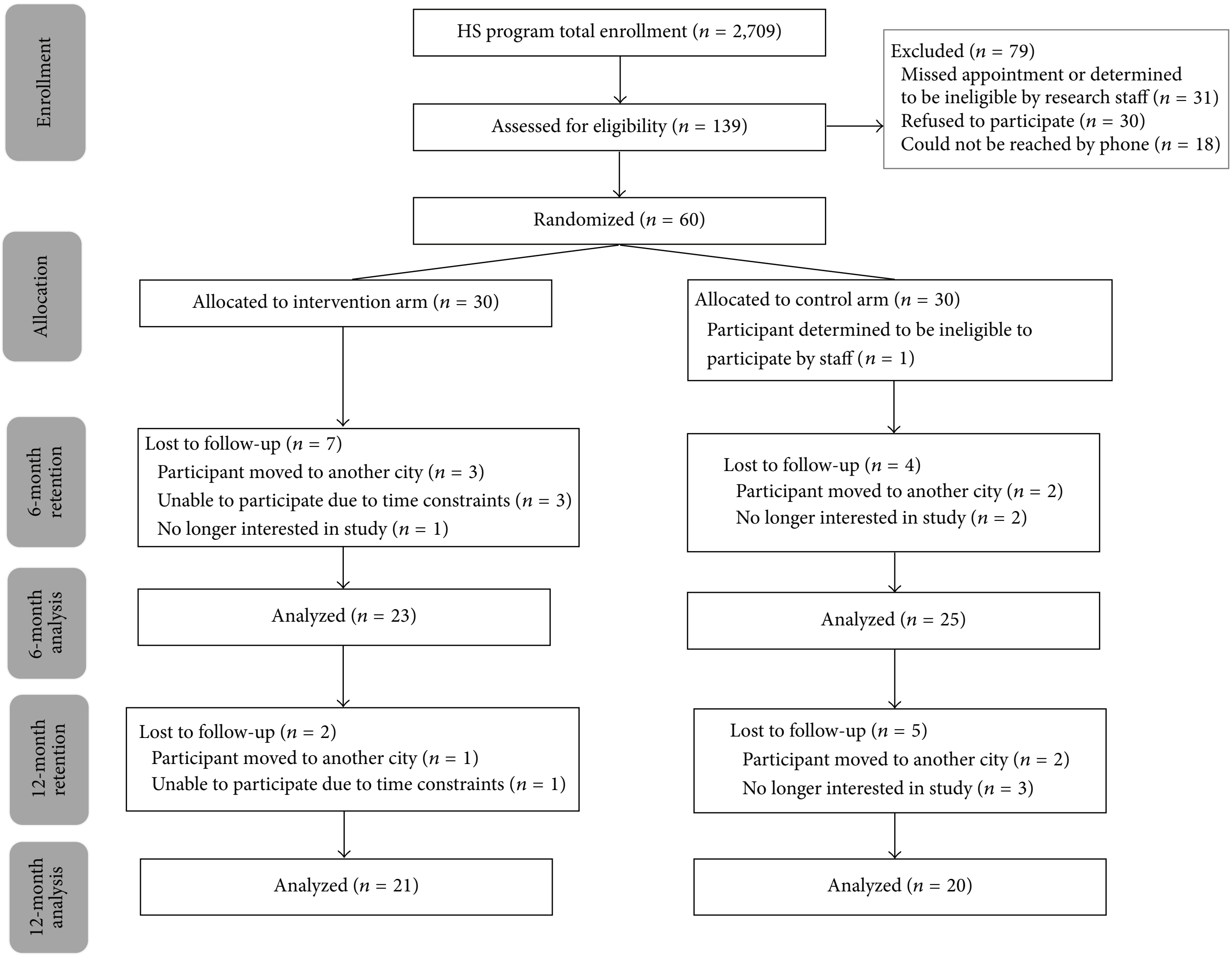

Figure 1: Recruitment and retention efforts.

a standardized approach of discussing five main areas (positive deviance behaviors) when conducting home visits and phone calls throughout the trial. Their discussion of each area by proportion of all documented interactions was perceptions of weight, 84.3% (95% CI: 75.9, 92.7); snacking strategies, 95.3% (95% CI: 91.6, 99.0); dealing with behavior problems and emotions, 69.2% (95% CI: 56.2, 82.2); organization and taking control, 77.1% (95% CI: 67.8, 86.5); and figuring out why healthy habits are important, 78.6% (95% CI: 69.3, 87.7).

Comparing the baseline demographics and anthropometrics, there were no significant differences between the randomized groups (Table 1). The parents enrolled were 100% Hispanic and had overall low income. There was no difference in baseline demographics between completers ($n = 48$) and noncompleters ($n = 12$) at six months. Those completing the twelve-month visit were less likely to be employed at baseline (44%) compared to noncompleters (78%), $p = 0.05$, and otherwise there were no differences.

For the outcome of BMI z-score, there was no difference in the mean change between the parent mentor and community health worker groups (mean difference: −0.02 (95% CI: −0.26, 0.22)). Both had a significant reduction in mean BMI z-score by time ($p < 0.001$, Table 2). Using estimated marginal means adjusted for baseline values, the estimated change in BMI z-score from baseline to end of intervention at six months was −0.24 (95% CI: −0.34, −0.15), and that between the end of intervention and the twelve-month time point was 0.00 (95% CI: −0.10, 0.11). When separated by baseline BMI z-score quartiles, participants starting at a higher z-score intercept had the largest overall z-score change with a mean of −0.68 (95% CI: −1.1, −0.24).

There was no effect on systolic blood pressure; diastolic blood pressure percentiles decreased overall by a mean of −5.53 (95% CI: −9.74, −1.31) at six months, with no effect by group ($p = 0.96$) (Table 2). For sleep, no differences by group were observed; the mean baseline for the parent mentor group was 10.7 hours (SD = 1.42) and was 10.7 (SD = 1.40) for the community health worker group. In the analysis adjusting for baseline and multiple measures, there was a significant increase from baseline to six months ($p = 0.04$) but then there was a decrease from six months to twelve months ($p = 0.002$) resulting in overall no difference between baseline

Table 1: Baseline demographic characteristics of study children and parents(1).

Characteristics	Parent mentor group	Community health worker group	$p^{(2)}$
Child age, months, mean (SD)	54.4 (7.8)	51.1 (6.9)	0.08
Child sex, % female (n)‡	36.7% (11)	50.0% (15)	0.44
Parental age, years, mean (SD)	30.7 (7.6)	31.5 (6.9)	0.66
Parent sex, % female (n)‡	93.3% (28)	96.7% (29)	1.00
Preferred language, % English (n)‡	56.7% (17)	56.7% (17)	1.00
Parent BMI, mean (SD)	31.4 (8.3)	33.0 (6.7)	0.49
Hispanic, % (n)	100% (30)	100% (30)	
Household size, median (IQR)+	5.0 (1.3)	4.5 (3.0)	0.18
Income, % (n)‡			0.78
Less than $10,000	30.0% (9)	30.0% (9)	
$10,000–$25,000	30.0% (9)	43.3% (13)	
$25,000–$50,000	10.0% (3)	6.7% (2)	
Greater than $50,000	3.3% (1)	0.0% (0)	
Do not know/not sure	26.7% (8)	20.0% (6)	
Employment, % (n)‡			0.48
Employed/self-employed	46.7% (14)	63.3% (19)	
Unemployed/unable to work/student	30.0% (9)	20.0% (6)	
Homemaker	23.3% (7)	16.7% (5)	
Education, % (n)‡			0.62
Less than high school education	43.3% (13)	46.7% (14)	
High school graduate/GED	13.3% (4)	20.0% (6)	
Some college or technical school/college graduate	43.3% (13)	33.3% (10)	

(1) n = 30 in the parent mentor group and community health worker group at baseline. GED: General Education Development Test; BMI: body mass index.
(2) p values are calculated by independent-samples t-test unless otherwise noted. + denotes use of independent-samples Mann-Whitney U test; ‡: Fisher's Exact Test.

and twelve months ($p = 0.16$) (Table 2). Weekday screen time had a trend toward significance in the interaction of randomization group × time ($p = 0.08$) with the intervention group decreasing screen time from a mean of 3.3 (95% CI: 2.3, 4.2) at six months to 2.1 (95% CI: 1.5, 2.7) at twelve-month follow-up.

Out of the forty-one participants who completed the six-month postintervention, 12.2% (5) had a growth (height) velocity < 50th percentile, 29.3% (7) were between the 50th and 90th percentile, and 70.7% (29) had a growth velocity > 90th percentile.

For the nonrandomized control group comparison, their baseline BMI z-score was 2.65 (95% CI: 2.38, 2.93) (Table 3) and their mean age at baseline was 45.6 months (95% CI: 44.0, 47.2). The difference between their baseline and six-month BMI z-score was not significant ($p = 0.08$, paired t-test). As a group over a twelve-month period, they did have a significant decrease in BMI z-score of −0.32 (95% CI: −0.53, −0.10), with a mean z-score at twelve months of 2.33 (95% CI: 2.02, 2.66).

Using the Block FFQ as the primary assessment of dietary intake, there was a significant reduction in sugary beverage intake overall with a mean change of −0.14 servings (95% CI: −0.23, −0.04) at six months but not by group ($p = 0.96$), with the significance occurring between baseline and end of intervention at six months ($p = 0.001$) and sustained with no change at twelve months (six months after intervention) ($p = 0.83$ for six versus twelve months) (Table 4). There was also a significant decrease in sugar added to food or drink over time of −1.22 tsp (95% CI: −2.12, −0.32), and no changes were seen by time or group for vegetable intake ($p = 0.36$ for time) or whole grain intake ($p = 0.12$). The overall caloric intake decreased between baseline and six months with a mean difference of −119.99 (95% CI: −252.23, 12.25 $p = 0.07$) and was then stable between end of intervention and twelve months ($p = 0.51$).

The quality of life scales assessed using the PedsQL 4.0 showed no significant changes from baseline to end of intervention or six months after intervention in either group, except in emotional functioning, with a significant increase occurring between baseline, 81.3 (95% CI: 76.9, 85.8), and end of intervention, 86.8 (95% CI: 83.1, 90.6) ($p = 0.003$). The following are mean overall scores for the intervention and comparison group throughout the trial: baseline, 84.4 (95% CI: 81.3, 87.5); end of intervention, 83.6 (95% CI: 79.2, 88.1); and six months after intervention, 85.7 (95% CI: 81.5, 90.0).

Finally, all of the CFPQ scales showed significance by time except the monitoring measure ($p = 0.24$) (Table 5). The "encourage balance and variety in diet" scale was the only measure to show significance by group ($p = 0.009$) with a higher score reported at the end of intervention and six months after intervention for the intervention group versus the comparison group, with mean score of 4.5 (95% CI: 4.2, 4.8), 4.8 (95% CI: 4.6, 5.0) for the intervention arm and 4.3 (95% CI: 4.0, 4.5), 4.5 (95% CI: 4.2, 4.7) for the comparison

TABLE 2: Primary and secondary clinical outcomes[(1)].

Measure[(3)]	Parent mentor group	Community health worker group	$p^{(2)}$ Group	Time	Group × time
Primary outcomes					
Child BMI z-score[a,c]			0.94	<0.001	0.94
Baseline	2.63 (2.4, 2.9)	2.61 (2.3, 2.9)			
6 months	2.48 (2.2, 2.7)	2.45 (2.1, 2.8)			
12 months	2.48 (2.2, 2.7)	2.31 (2.0, 2.6)			
Child BMI, kg/m^2[b,c]			0.96	0.002	0.82
Baseline	21.1 (20.0, 22.3)	20.6 (19.6, 21.6)			
6 months	21.5 (20.0, 23.0)	20.9 (19.6, 22.2)			
12 months	22.4 (20.7, 24.1)	21.1 (19.6, 22.5)			
Child weight, lbs.[a,b,c]			0.49	<0.001	0.90
Baseline	54.1 (48.5, 59.7)	49.8 (46.2, 53.3)			
6 months	61.2 (54.3, 68.2)	56.5 (51.4, 61.5)			
12 months	67.2 (59.3, 75.1)	60.5 (54.2, 66.7)			
Secondary outcomes					
Blood pressure, systolic percentile			0.68	0.79	0.28
Baseline	70.0 (63.3, 76.8)	77.9 (72.3, 83.5)			
6 months	73.6 (66.4, 80.8)	71.8 (64.5, 79.1)			
12 months	71.0 (63.9, 78.1)	76.1 (68.6, 83.6)			
Blood pressure, diastolic percentile[a,c]			0.97	<0.001	0.98
Baseline	83.5 (79.4, 87.6)	87.2 (84.3, 90.1)			
6 months	79.1 (73.5, 84.7)	79.8 (75.3, 84.3)			
12 months	76.4 (71.1, 81.7)	76.7 (70.1, 83.3)			
Screen time, hrs. per weekday[b]			0.49	0.04	0.08
Baseline	3.0 (2.5, 3.6)	2.3 (1.7, 2.8)			
6 months	3.3 (2.3, 4.2)	2.1 (1.4, 2.9)			
12 months	2.1 (1.5, 2.7)	2.2 (1.6, 2.8)			
Screen time, hrs. per weekend day[a]			0.41	0.003	0.39
Baseline	4.6 (3.6, 5.5)	3.0 (2.2, 3.7)			
6 months	2.9 (2.2, 3.6)	2.7 (1.7, 3.8)			
12 months	3.6 (2.7, 4.5)	2.9 (2.1, 3.6)			
Active play time, mins. per day[b]			0.78	0.03	0.78
Baseline	120.0 (87.5, 152.5)	118.7 (90.9, 146.4)			
6 months	132.4 (94.0, 170.7)	145.4 (104.1, 186.8)			
12 months	107.9 (74.6, 141.1)	108.0 (72.0, 144.0)			
Sleep, hrs. per day[a,b]			0.55	0.007	0.83
Baseline	10.7 (10.2, 11.2)	10.7 (10.1, 11.2)			
6 months	11.2 (10.5, 11.8)	10.9 (10.1, 11.6)			
12 months	10.4 (10.0, 10.8)	10.4 (9.8, 11.0)			

[(1)]Values are means (95% CIs); $n = 30$, 23, and 21 in the parent mentor group and 30, 25, and 20 in the community health worker group at baseline and at 6 and 12 months, respectively.

[(2)]Linear mixed-model analysis on the entire study population; p values are for the individual effects of group and time as well as their interaction.

[(3)a]0–6-month mean difference significance at a p value < 0.05; [b]6–12-month mean difference significance at a p value < 0.05; [c]0–12-month mean difference significance at a p value < 0.05.

Table 3: Head Start comparison control data(1).

Measure	Control	$p^{(2)}$	$p^{(3)}$	$p^{(4)}$
Child BMI z-score		0.08	0.29	0.005
Baseline	2.65 (2.38, 2.93)			
6 months	2.39 (2.02, 2.77)			
12 months	2.33 (2.02, 2.66)			
Child BMI, kg/m^2		0.69	0.31	0.40
Baseline	20.5 (19.7, 21.3)			
6 months	20.0 (18.9, 21.0)			
12 months	20.8 (19.5, 22.1)			
Child weight, lbs.		<0.001	<0.001	<0.001
Baseline	46.4 (43.3, 49.4)			
6 months	49.2 (45.1, 53.3)			
12 months	53.9 (49.3, 58.5)			

(1) Values are means (95% CIs); $n = 34$, 24, and 34 at baseline and at 6 and 12 months, respectively.
(2) p value calculated by paired-samples t-test between baseline and 6 months.
(3) p value calculated by paired-samples t-test between 6 months 12 months.
(4) p value calculated by paired-samples t-test between baseline and 12 months.

arm, respectively, over time. The scales that are most important and related to the intervention are environment, emotion regulation, restriction for health, restriction for weight control, and modeling. These scales were more heavily discussed during the parent mentor training before the beginning of the study.

4. Discussion

This is the first clinical trial to our knowledge that uses parent mentors as an intervention mechanism for childhood obesity. An important aspect of this trial was that it was conducted in a low-income, Hispanic population who, in the United States, are at higher risk of obesity compared with white children [1]. The data on recruitment, participation, and retention suggest that a full-scale clinical trial would be feasible in this setting. The high participation rates for both intervention and comparison groups in the present study indicate that our approach was successful in terms of engaging and motivating parents of obese children. Moreover, our findings provide evidence that parent mentors are effective at facilitating this type of engagement in their peers. It has been suggested that interventions sponsored or supported by government agencies and/or big organizations (i.e., top-down approaches) are more sustainable compared to bottom-up approaches like interventions driven by community-based organizations [30]. Our parent mentor intervention was driven by an independent social network, which is different compared to standard bottom-up approaches that are dependent on formal institutional support. This is significant because it suggests that a positive deviance approach, with peer mentors serving as agents of change, may hold the key to improving sustainability. At the same time, the relative success of these mentors may be dependent on their own capacities, and the variation between mentors in efficacy will need further testing in full-scale trial.

Both the parent-child dyads randomized to receive a parent mentor and those randomized to receive health education from a community health worker experienced a decrease in their adiposity as measured by BMI z-score. The diet and activity changes that were measured were consistent with this decrease in adiposity, and the plateauing of those diet and activity changes between the end of the intervention at six months and the twelve-month follow-up is consistent with their weight stabilization. We did not have a control group that was randomized to receive no intervention. A recent study comparing childhood obesity interventions with and without a true control group suggests that careful interpretation of results in those without a true control should be considered due to possible regression to the mean and biases favoring resolution [31]. For the control group that we did employ, the primary influence on them was their enrollment in the Head Start program. The reduction in the control group's BMI z-scores over twelve months makes it impossible to attribute the reduction seen in both of our intervention groups to the intervention. However, the lack of a significant effect in the first six months for the control children in contrast to the stronger reduction in the first six months of the two intervention groups suggests there is some additional benefit to receiving the intervention that should be evaluated in a larger clinical trial.

Other trials demonstrating success in reducing adiposity in this age group have utilized multidisciplinary teams including a dietician, psychologist, or behavioral counselor and some physical activity coaching [7, 8]. One trial specifically tested a mentoring component in addition to multidisciplinary education and found a significant benefit of health coaching by a paraprofessional mentor compared with the educational intervention alone [6, 32]. In a multidisciplinary intervention study with a usual care control [8], a larger effect size on BMI z-score was seen (mean difference −0.77, 95% CI: −0.27, −1.26) than in our study; other studies using a degree of intensity more similar to that described in this study (using motivational interviewing [5] or health coaches [6]) have seen a similar, more modest effect.

One important aspect of this study was its conduct in partnership with a Head Start program. While the Head Start program staff did not provide any direct education for the parents involved in the study, they did encourage their involvement. The potential for a scalable and effective program for reducing obesity has significant potential impact given the scope of Head Start and the population the programs serve [11]. Prior studies targeting obesity in Head Start have been mixed with one study showing no reduction in adiposity and even increases in some groups [33], whereas others have found decreases associated with usual Head Start participation [34]. Another series of trials found no significant effect with a weight-focused intervention [35] but then after including a parent-focused component found significant decreases from baseline in both the intervention and the control groups, suggesting a possible role for usual Head Start participation.

Table 4: Block Kids Food Screener results(1).

Measure(3)	Parent mentor group	Community health worker group	$p^{(2)}$ Group	Time	Group × time
Fruit/fruit juice, cups[c]			0.47	0.01	0.79
Baseline	1.4 (1.0, 1.7)	1.3 (1.0, 1.6)			
6 months	1.3 (0.9, 1.6)	1.2 (0.9, 1.5)			
12 months	1.1 (0.8, 1.4)	1.0 (0.8, 1.2)			
Vegetables, cups			0.52	0.36	0.90
Baseline	0.5 (0.3, 0.6)	0.6 (0.2, 0.9)			
6 months	0.4 (0.3, 0.6)	0.6 (0.2, 0.9)			
12 months	0.4 (0.2, 0.6)	0.4 (0.2, 0.5)			
Potatoes, including French fries, cups			0.50	0.15	0.89
Baseline	0.2 (0.1, 0.3)	0.2 (0.1, 0.4)			
6 months	0.2 (0.1, 0.2)	0.2 (0.1, 0.3)			
12 months	0.2 (0.1, 0.2)	0.1 (0.1, 0.2)			
Whole grains, ounces			0.58	0.12	0.53
Baseline	0.5 (0.3, 0.7)	0.3 (0.2, 0.4)			
6 months	0.5 (0.3, 0.6)	0.5 (0.3, 0.7)			
12 months	0.5 (0.3, 0.7)	0.3 (0.2, 0.5)			
Saturated fat, grams			0.79	0.13	0.44
Baseline	15.2 (11.2, 19.3)	14.4 (7.8, 20.9)			
6 months	13.8 (8.1, 19.5)	13.1 (7.9, 18.4)			
12 months	13.3 (6.9, 19.8)	10.9 (8.4, 13.4)			
Meat, poultry, and fish, ounces			0.85	0.51	0.59
Baseline	1.8 (1.3, 2.4)	2.1 (0.8, 3.4)			
6 months	2.1 (1.0, 3.3)	2.1 (1.0, 3.3)			
12 months	2.2 (0.9, 3.4)	1.5 (1.0, 2.0)			
Dairy products, cups			0.52	0.06	0.77
Baseline	1.8 (1.4, 2.2)	1.4 (1.0, 1.8)			
6 months	1.5 (1.1, 1.8)	1.4 (1.0, 1.8)			
12 months	1.4 (1.0, 1.8)	1.2 (1.0, 1.4)			
Legumes, cups			0.85	0.19	0.18
Baseline	0.2 (0.1, 0.2)	0.2 (0.1, 0.2)			
6 months	0.1 (0.1, 0.2)	0.2 (0.1, 0.2)			
12 months	0.1 (0.1, 0.2)	0.1 (0.0, 0.1)			
Sugar added to foods/drinks, tsp[a,c]			0.54	<0.001	0.48
Baseline	5.9 (4.0, 7.7)	5.3 (3.6, 7.1)			
6 months	4.5 (2.2, 6.9)	4.3 (2.8, 5.8)			
12 months	4.7 (3.1, 6.2)	3.5 (2.4, 4.6)			
Sugars occurring in foods and juice, grams[a,c]			0.65	<0.001	0.53
Baseline	74.5 (58.2, 90.7)	68.4 (51.5, 85.2)			
6 months	62.5 (45.2, 79.8)	60.7 (44.1, 77.3)			
12 months	59.4 (43.6, 75.2)	48.7 (40.1, 57.3)			
Fiber, grams			0.43	0.06	0.83
Baseline	10.6 (8.1, 13.1)	11.2 (7.0, 15.4)			
6 months	9.6 (7.2, 11.9)	10.1 (6.0, 14.2)			
12 months	9.4 (6.4, 12.5)	7.5 (5.8, 9.1)			

Table 4: Continued.

Measure[3]	Parent mentor group	Community health worker group	$p^{(2)}$ Group	Time	Group × time
Yogurt, containers per week			0.45	0.24	0.43
Baseline	2.9 (1.7, 4.0)	2.2 (0.9, 3.5)			
6 months	2.7 (1.4, 4.1)	2.3 (1.4, 3.3)			
12 months	2.7 (1.3, 4.2)	3.5 (1.6, 5.3)			
Sugary beverages, servings[a,c]			0.96	0.001	0.74
Baseline	0.3 (0.2, 0.4)	0.3 (0.2, 0.4)			
6 months	0.2 (0.1, 0.3)	0.2 (0.1, 0.2)			
12 months	0.2 (0.1, 0.2)	0.1 (0.1, 0.2)			
Energy from sugary beverages, kcals[a,c]			0.94	<0.001	0.63
Baseline	37.1 (14.7, 59.5)	40.2 (20.6, 59.8)			
6 months	18.2 (6.6, 29.7)	23.3 (12.0, 34.5)			
12 months	19.6 (9.0, 30.2)	17.7 (6.5, 28.9)			
Protein intake, kcal percentage			0.97	0.37	0.74
Baseline	17.1 (13.2, 21.0)	17.0 (9.5, 24.5)			
6 months	18.0 (11.6, 24.4)	18.4 (10.4, 26.3)			
12 months	20.3 (11.9, 28.7)	16.3 (12.3 20.3)			
Fat intake, kcal percentage			0.68	0.10	0.26
Baseline	35.3 (25.9, 44.7)	35.4 (18.5, 52.2)			
6 months	36.5 (21.2, 51.9)	34.0 (19.6, 48.4)			
12 months	39.9 (20.0, 59.8)	31.8 (24.3, 39.4)			
Carbohydrate intake, kcal percentage[a,c]			0.37	<0.001	0.80
Baseline	50.9 (39.4, 62.5)	47.4 (32.4, 62.5)			
6 months	48.7 (34.5, 63.0)	47.5 (31.2, 63.8)			
12 months	52.0 (35.8, 68.3)	42.0 (34.0, 50.1)			
Total estimated energy intake, kcals[a]			0.64	0.02	0.56
Baseline	1,122.6 (858.1, 1,387.0)	1,086 (657.0, 1,515.9)			
6 months	1,016.6 (664.1, 1,369.1)	983.1 (604.8, 1,361.5)			
12 months	985.8 (595.2, 1,376.5)	792.5 (624.3, 960.7)			

(1) Basic nutritional information regarding daily intake of study children. Values are means (95% CIs); $n = 30$, 23, and 21 in the parent mentor group and 30, 23, and 20 in the community health worker group at baseline and at 6 and 12 months, respectively; tsp: teaspoon; kcals: kilocalories.
(2) Linear mixed-model analysis on the entire study population; p values are for the individual effects of group and time as well as their interaction.
(3) [a]0–6-month mean difference significance at a p value < 0.05; [b]6–12-month mean difference significance at a p value < 0.05: (for this table no significant differences were found at 6–12 months); [c]0–12-month mean difference significance at a p value < 0.05.

Using the CFPQ, we observed an increase in parental report of more child self-control of their own eating behaviors, a decrease in regulation of child's emotional states through use of food, an increase in parent promotion of well-balanced food intake, an increase in availability of healthy foods in the home, a decrease in use of food as a reward for child behavior, an increase in encouragement of child's own involvement in meal planning and preparation, an increase in parent demonstration of healthy eating, a decrease in parent pressure of child eating more food at meals, an increase in parent control of child's food intake to limit less healthy foods and maintain child's weight, and an increase in techniques to encourage consumption of healthy foods. One challenge of using the positive deviance method to develop the intervention is that there were no specific behavioral mapping tools for the targeted behaviors. However, given that one area of the positive deviance-based intervention was on how to address behaviors without food, the CFPQ findings are encouraging that the intervention had a causal relationship with the behavior changes reported. Interestingly, the only difference between the intervention and comparison group was an increase in parent reported encouragement of a balanced and varied diet in the intervention group. Prior observational studies have shown a correlation between restrictive feeding practices and increased risk for overweight [36–38]; however, some studies have suggested a role for restriction at least in early childhood [39], and the role of restrictive practices in the context of an intervention for obesity where a parent is trying to change patterns is less clear and should be explored in future interventional studies.

Table 5: Child Comprehensive Feeding Practices Questionnaire (CFPQ) results[(1)].

Measure[(3)]	Parent mentor group	Community health worker group	$p^{(2)}$ Group	Time	Group × time
Child control (allow child control of eating behavior)[a,c]			0.49	<0.001	0.77
Baseline	2.5 (2.3, 2.8)	2.7 (2.4, 3.0)			
6 months	2.3 (2.0, 2.6)	2.2 (1.9, 2.5)			
12 months	2.3 (2.0, 2.6)	2.3 (1.9, 2.6)			
Emotion regulation (parent uses food to regulate emotion)[a,c]			0.34	<0.001	0.62
Baseline	1.5 (1.2, 1.7)	1.7 (1.4, 2.0)			
6 months	1.4 (1.1, 1.7)	1.3 (1.1, 1.5)			
12 months	1.3 (1.1, 1.5)	1.2 (1.0, 1.3)			
Encourage balance and variety in diet[b,c]			0.009	0.001	0.12
Baseline	4.4 (4.2, 4.6)	4.3 (4.0, 4.5)			
6 months	4.5 (4.2, 4.8)	4.3 (4.0, 4.5)			
12 months	4.8 (4.6, 5.0)	4.5 (4.2, 4.7)			
Environment (make healthy foods available in home)[a,b,c]			0.22	<0.001	0.48
Baseline	3.7 (3.3, 4.1)	3.4 (3.0, 3.7)			
6 months	4.4 (4.2, 4.7)	4.1 (3.8, 4.3)			
12 months	4.3 (4.0, 4.5)	3.9 (3.6, 4.2)			
Food as reward for behavior[a,c]			0.17	<0.001	0.39
Baseline	2.4 (2.0, 2.8)	2.6 (2.2, 2.9)			
6 months	1.8 (1.4, 2.1)	2.2 (1.7, 2.6)			
12 months	2.0 (1.6, 2.4)	2.3 (1.8, 2.8)			
Encourage child involvement in meal planning/preparation[a,c]			0.45	<0.001	0.78
Baseline	3.1 (2.8, 3.5)	3.1 (2.7, 3.5)			
6 months	3.6 (3.1, 4.1)	3.5 (3.1, 3.8)			
12 months	3.6 (3.1, 4.1)	3.4 (3.0, 3.9)			
Modeling (parent demonstrates healthy eating)[a,c]			0.31	<0.001	0.53
Baseline	3.8 (3.5, 4.2)	3.7 (3.3, 4.1)			
6 months	4.6 (4.2, 4.9)	4.4 (4.1, 4.7)			
12 months	4.5 (4.2, 4.8)	4.2 (3.8, 4.6)			
Monitoring (parent tracks less healthy foods)			0.82	0.24	0.96
Baseline	3.7 (3.3, 4.0)	3.5 (3.2, 3.9)			
6 months	3.6 (3.1, 4.2)	3.3 (2.9, 3.8)			
12 months	3.8 (3.4, 4.3)	3.6 (3.1, 4.1)			
Pressure (parent pressures child to eat more food at meals)[a,c]			0.63	0.006	0.65
Baseline	2.6 (2.2, 3.0)	2.2 (1.9, 2.5)			
6 months	2.2 (1.8, 2.7)	2.2 (1.7, 2.6)			
12 months	2.2 (1.7, 2.6)	1.9 (1.4, 2.4)			
Restriction for health (parent controls intake to restrict less healthy foods)[a]			0.11	0.05	0.04
Baseline	3.9 (3.5, 4.2)	3.7 (3.4, 4.1)			
6 months	4.4 (4.1, 4.6)	3.8 (3.3, 4.3)			
12 months	4.1 (3.7, 4.4)	4.0 (3.6, 4.4)			

Table 5: Continued.

Measure[3]	Parent mentor group	Community health worker group	$p^{(2)}$ Group	Time	Group × time
Restriction for weight control (parent controls intake to influence weight)[a,c]			0.13	0.05	0.37
Baseline	2.8 (2.4, 3.2)	3.1 (2.7, 3.5)			
6 months	3.3 (2.9, 3.7)	3.2 (2.8, 3.7)			
12 months	3.3 (2.8, 3.7)	3.2 (2.7, 3.7)			
Teaching about nutrition (explicit instruction to encourage healthy foods)[a,c]			0.37	<0.001	0.21
Baseline	3.9 (3.5, 4.2)	3.6 (3.2, 3.9)			
6 months	4.5 (4.2, 4.8)	4.0 (3.7, 4.4)			
12 months	4.3 (4.0, 4.6)	4.2 (3.8, 4.5)			

[1] The CFPQ scales (range: 1–5) with higher scores indicating more agreement with the feeding behavior or higher frequency of the practice. Values are means (95% CIs); $n = 30$, 23, and 21 in the parent mentor group and 30, 23, and 20 in the community health worker group at baseline and at 6 and 12 months, respectively.
[2] Linear mixed-model analysis on the entire study population; p values are for the individual effects of group and time as well as their interaction.
[3] [a] 0–6-month mean difference significance at a p value < 0.05; [b] 6–12-month mean difference significance at a p value < 0.05; [c] 0–12-month mean difference significance at a p value < 0.05.

Finally, reporting bias is certainly a possible influence on the CFPQ results, particularly after intervention.

The change in the health-related quality of life measure of emotional functioning may be a result of the interventions or relating to the natural maturation process. Also, the initial scale ratings for quality of life are lower than previously reported means of healthy children [40] and similar to that of another study of obese preschoolers [41]. However, these could also be unrelated to the child's weight status and be more related to their socioeconomic status or another confounding variable.

The limitations of this study include the secondary outcome measures of screen time, activity and sleep being by parental report, though any recall bias would probably have affected both groups equally. The limitation of no true control that was randomized is discussed above, though this study does add to the literature on describing the potential effect of usual Head Start participation. The study was underpowered to detect a difference between groups for a small effect size on adiposity, which is what we observed. However, the focus of this study was on feasibility of a novel intervention and study design. Finally, we cannot separate the effect of the content delivery versus the health coaching or support by the *promotora* with this study design.

5. Conclusion

A significant challenge in addressing the childhood obesity epidemic, particularly the disparities seen in minority populations, requires scalable and culturally acceptable interventions. The data presented suggest that the method of using parent mentors with minimal training is a potentially feasible intervention with a small effect size that warrants further exploration. Positive deviance as a method of deriving solutions from a high-risk community also warrants further testing in clinical studies. Finally, the role of early education centers, particularly Head Start, in addressing early childhood obesity is promising from both this and other recent studies.

Disclosure

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Competing Interests

The authors declare that there are no competing interests regarding the publication of this paper.

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